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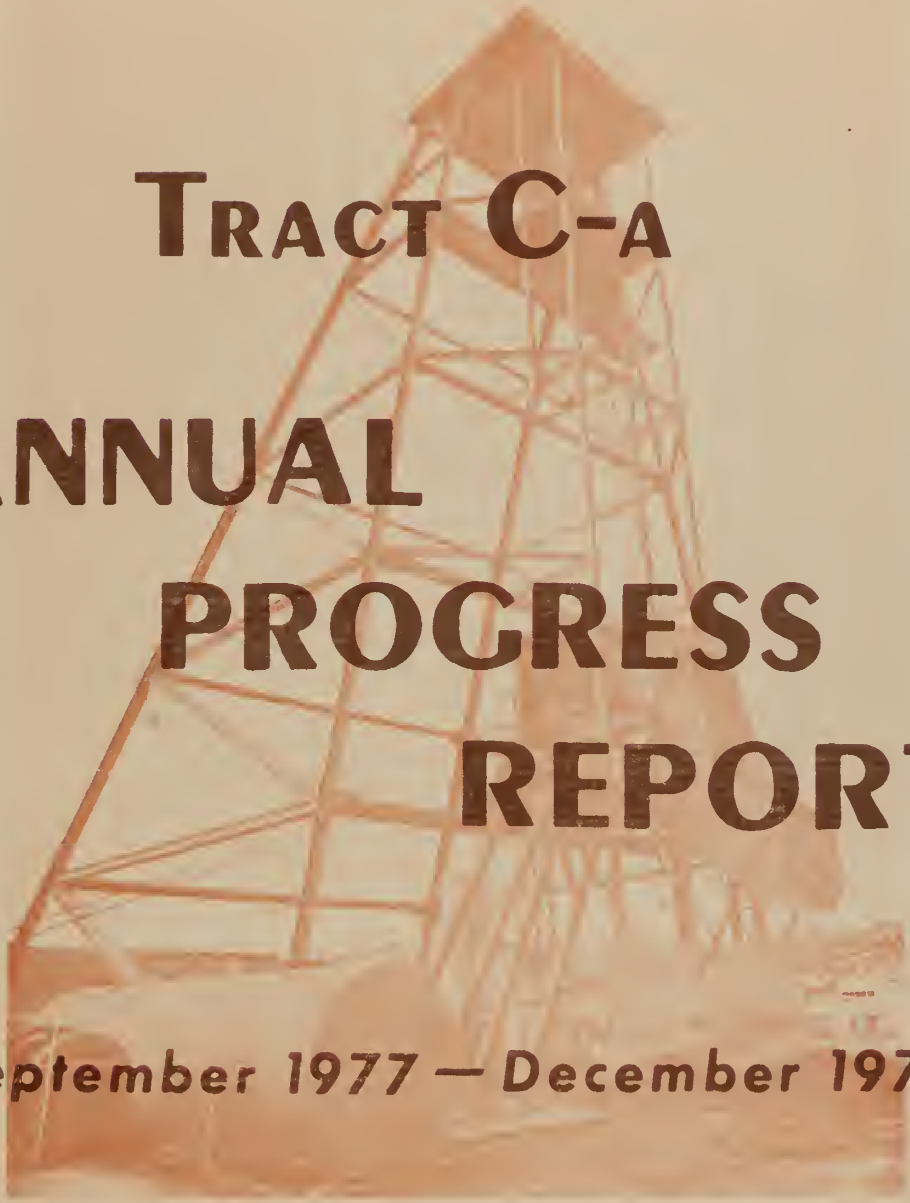

Tract C-a

ANNUAL PROGRESS REPORT

September 1977 — December 1978

Gulf Oil Corporation / Standard Oil Company (Indiana)
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ANNUAL PROGRESS REPORT
TRACT C-a

September 1977 — December 1978

Gulf Oil Corporation / Standard Oil Company (Indiana)
March, 1979

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RBOSC PROGRESS REPORT

SEPTEMBER 22, 1977 THROUGH DECEMBER 31, 1978

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SECTION I

INTRODUCTION & SUMMARY

CHAPTER 1
PROJECT BACKGROUND

1.1 INTRODUCTION

This first Annual Progress Report (APR) describes the operational and monitoring programs performed by the Rio Blanco Oil Shale Company (hereafter RBOSC) on Federal Tract C-a from September 22, 1977 through December 31, 1978. The Gulf Oil Corporation and Standard Oil Company (Indiana) formed RBOSC as a general partnership to develop Tract C-a with the intention of engaging in the commercial production of oil shale.

The requirement to submit an annual progress report on each anniversary date of the lease following approval of a development plan is contained in Section 1(C)(4) of the Environmental Stipulations to the oil-shale lease (Serial No. C-20046) under which RBOSC is operating. This annual report is defined to include a report on the monitoring programs. Since approval to develop Tract C-a was not received by RBOSC from the Department of the Interior (DOI) until September 22, 1977, this report contains the operational progress from that date. Hereafter, the APR will cover the previous calendar year. An environmental monitoring report is submitted separately for the seasonal year (December 1 - November 30) for biologic, air quality and meteorologic data and the water year (November 1 - October 31) for hydrologic data. Section 7 of this report contains a concise summary of the environmental programs for the seasonal year.

1.2 HISTORY PRIOR TO DEVELOPMENT

Effective March 1, 1974, Gulf and Standard acquired a lease on Tract C-a in the Piceance Creek basin of northwest Colorado as part of the Federal Prototype Oil Shale Leasing Program. The winning bonus bid of $210,305,600 gave Gulf and Standard exclusive rights to develop oil-shale reserves within the tract. The tract is located in Rio Blanco County as shown in Figure 1-1-1, some 200 miles west of Denver, Colorado.

Soon after obtaining the lease for Tract C-a, RBOSC began an extensive geotechnical and environmental data collection program to establish baseline conditions within and around the tract. The geotechnical program developed information on the geologic structure, stratigraphy and resources present within the tract. This included an evaluation of the underground water system to define aquifer characteristics, quality, and quantity of water expected to be produced from various mining plans. The environmental program was aimed not only at defining baseline conditions existing on the tract prior to development, but also at determining the most environmentally acceptable methods of developing the tract. Special monitoring studies were conducted on meteorology, air quality, terrestrial ecology, aquatic biology and cultural resources.

RBOSC initially planned to develop Tract C-a using open-pit mining and surface retorting. In March 1976, a Detailed Development Plan outlining this approach was submitted for government approval. However, a number of environmental and economic factors caused RBOSC to reconsider using this approach. As was the case with the other federal oil-shale tract in Colorado, C-b, high background levels of several air quality parameters were observed during the environmental baseline monitoring program. In addition, off-tract land for processing facilities and disposal of overburden and processed shale was not available from the government as originally anticipated. As a result of these and other problems, a one-year lease suspension was granted by the government to begin on September 1, 1976.

During the suspension period, RBOSC continued to evaluate other types of technology which could be used to develop the tract and eliminate some of the problems that were anticipated with open-pit mining and surface retorting. It was concluded that modified in situ technology, based on work done by the Lawrence Livermore Laboratory and other national

REGIONAL MAP SHOWING LOCATION OF TRACT C-a

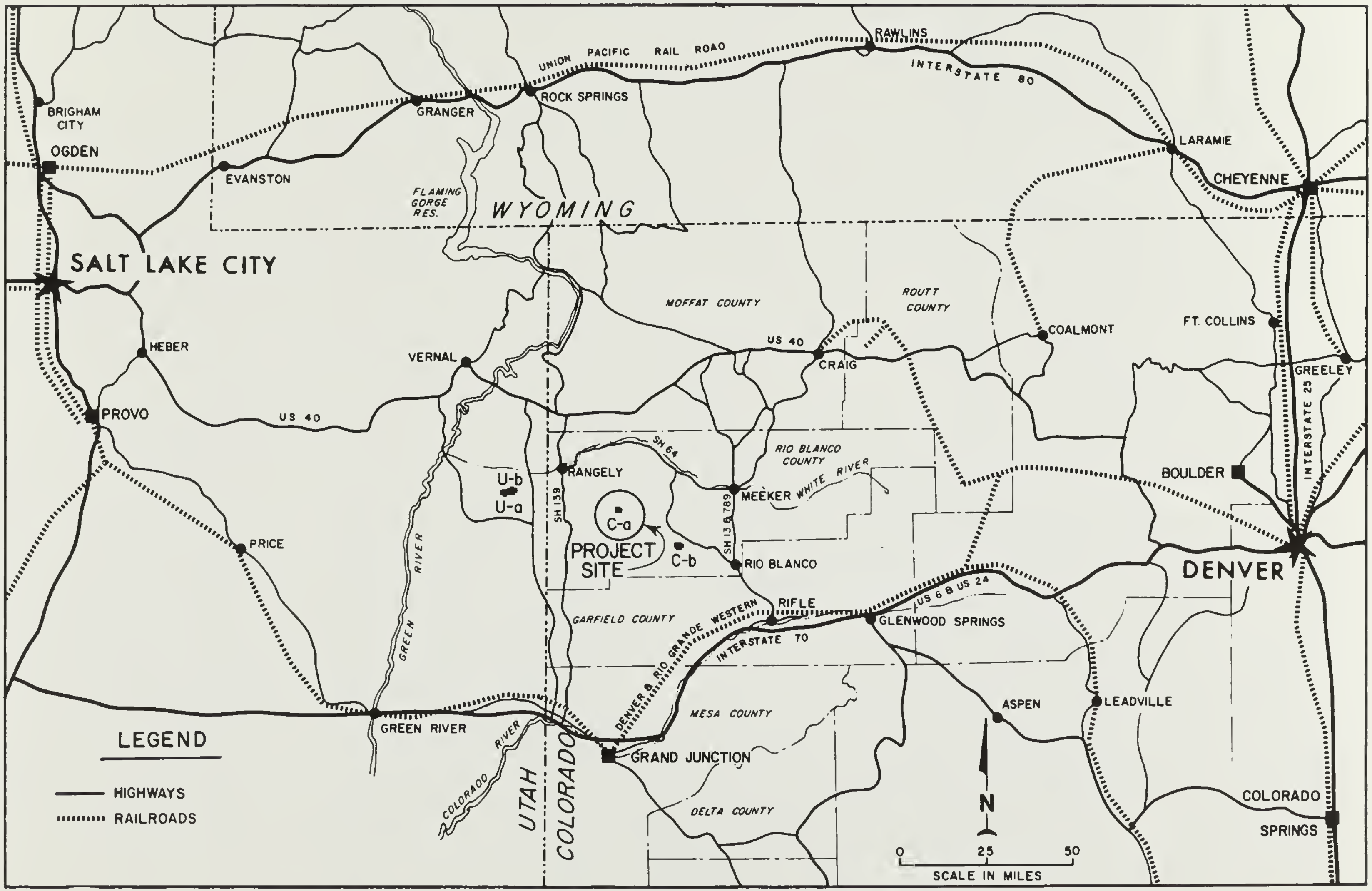


FIGURE 1-1-1

laboratories, provided many advantages. In May of 1977, a Revised Detailed Development Plan (DDP) based on modified in situ (MIS) technology was submitted for governmental approval. More than 150 copies of the DDP were distributed by the Area Oil Shale Office (AOSO) for review and comment to federal, state and local government agencies and the interested public. In addition, public hearings were held in Rangely and Denver, Colorado in July 1977. The AOSO considered comments received and requested additional information which was submitted as supplemental material to the DDP in early September 1977. On September 22, 1977, the DDP was approved by the Department of the Interior allowing development of Tract C-a to commence.

CHAPTER 2
PROJECT OVERVIEW

2.1 DESCRIPTION AND SCHEDULE OF PROJECT

The ultimate goal of RBOSC is to engage in commercial production of shale oil and associated by-products from Tract C-a at the highest production rate feasible, consistent with environmental, technical and economic constraints that now prevail or may exist in the future. The plan for developing oil shale resources on Tract C-a includes a Modular Development Phase (MDP) and a Commercial Phase. The MIS retorts for the commercial production include the richest, thickest oil shale within Tract C-a. The Commercial Phase will consist of modified in situ recovery of shale oil, on-tract surface retorting of ore brought to the surface, on-tract disposal of processed shale and waste materials, and on-tract support facilities. The MIS method to be used by RBOSC employs well-known mining methods in combination with technology similar to in situ recovery of heavy oil from sand reservoirs in oil fields. Mining involves the sinking of vertical shafts, drifting away from the shafts, and developing rubblized cells which become underground retorts. The deposit is divided into cells of rubblized oil shale separated by pillars of undisturbed oil shale. Because most retorting occurs underground, the need for large off-tract processing and disposal areas is eliminated. The MIS method is considered by RBOSC as the best currently available technique for achieving a combination of good resource recovery, minimum environmental impact and economic acceptability.

The MDP of tract development consists of underground retorting only; it will be conducted near the center of the commercial mine area during the first 10 years of operation (1978-87, including construction). Gulf and Standard have authorized a 5-retort program costing $93 million during 1977-82. The retorts will be built and burned in sequence to gain operating experience, improve process efficiency, and confirm capital and operating cost estimates. Retort 1, planned to start up in 1980, will allow evaluation of the retorting model prediction, provide practical field operating experience and supply oil-shale samples for laboratory and field experiments. The next four retorts will test mining concepts and factors affected by scale-up of the size of the retorts. These four retorts are scheduled to be developed and burned in 1980 through 1982. A conceptual drawing of the five retorts for the MDP is shown in Figure 1-2-1.

Engineering and construction for the Commercial Phase could begin in 1984 if warranted by the results from the 5-retort program. Completion of commercial-size retorts and support facilities would take about four years. During this period, additional retorts may be constructed and burned as part of the MDP.

It is currently expected that retorts for the Commercial Phase might have void ratios of approximately 20% produced by mining and rubblization. Ore produced in developing the voids would be crushed underground and stockpiled on the surface. The plan calls for the crushed ore to be retorted eventually in surface retorts to recover additional shale oil. Low-Btu off-gases produced in the Commercial Phase would be utilized for on-site power generation to supply most of the facility's electric requirements.

RBOSC is evaluating several methods of disposal of processed shale from surface retorting operations. The basic plan calls for disposal of processed shale in a natural gulch located on the tract. As final slopes are established at the disposal site, the processed shale would be covered by coarse, crushed materials and covered with soil previously stripped from the disposal area. The disposal pile would then be contoured, revegetated and progressively reclaimed as operations proceed. As an alternative, investigations are also underway to determine if part or all of the processed shale could be injected into spent retorts as a slurry that might achieve (1) ground stabilization, (2) sealing of the retorts against possible leaching by groundwater, and (3) disposal of the processed shale.

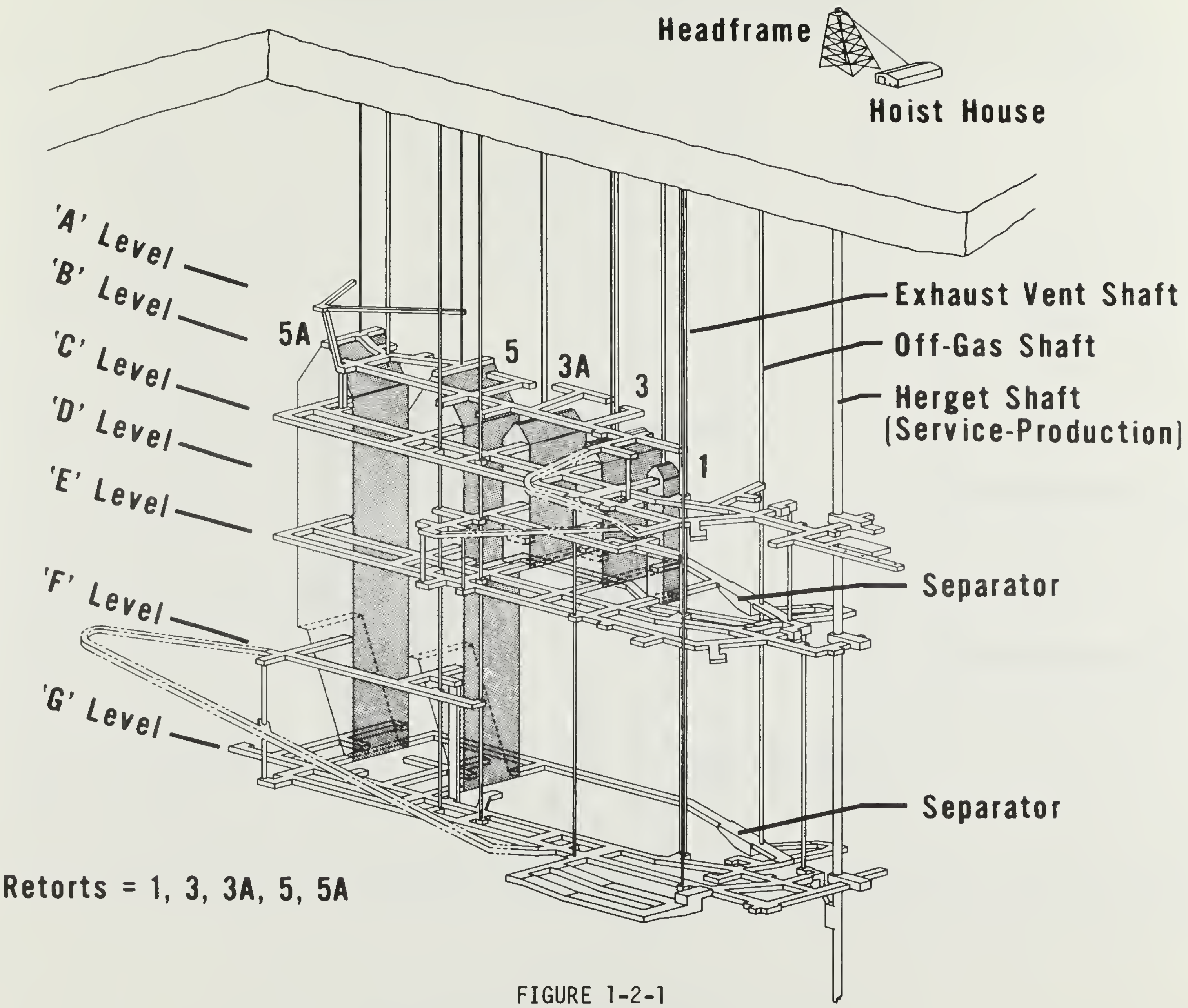


FIGURE 1-2-1
MDP MINE DEVELOPMENT

Mine dewatering during both the Modular Development and Commercial Phases will produce more water than is required for project needs. Tests to dispose of excess water during the MDP by reinjection on-tract are being carried out. Only small amounts of groundwater will be consumptively used during the MDP. During the Commercial Phase, approximately 2200 acre-feet per year of groundwater will be used.

Although the DDP originally showed the scheduled first burn to be in late 1979, unforeseen problems caused this burn to be delayed until 1980. The delays encountered were primarily due to adverse weather and shaft environment conditions.

The winter of 1978-79 was one of the coldest in Colorado recorded history. This cold weather, coupled with many snowstorms and a 50 to 60 mile minimum one-way commuting distance for most workers, led to high absenteeism and manpower turnover in critical construction areas. Many equipment failures and start-up problems were also attributed to the severe temperatures encountered. Record snowstorms in the Midwest caused long delays in equipment delivery.

Slippage in the shaft excavation schedule was mostly due to problems caused by water, gas and equipment failures. Despite five dewatering wells in the shaft area, water inflow to the shaft increased substantially by the end of the year. Mechanical and electrical failures of the shaft pumps resulted in flooding on several occasions. Hydrogen sulfide, encountered in shaft sinking, resulted in the withdrawal of the miners from the shaft several times. The combination of a wet shaft, high ventilation rates and cold temperatures resulted in uncomfortable working conditions which in turn contributed to a high labor turnover in this area.

Figure 1-2-2 illustrates the latest construction and operations schedule.

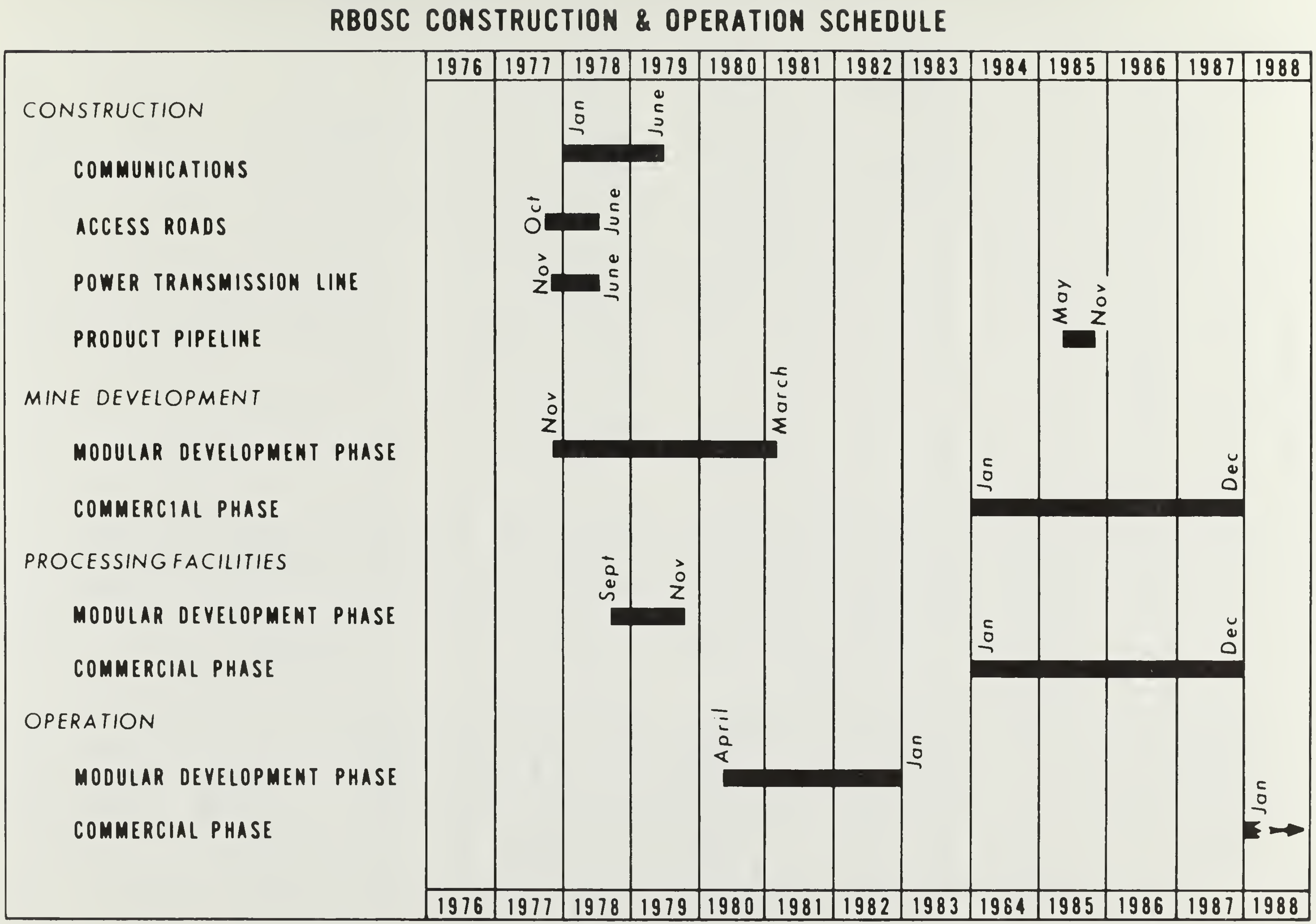


FIGURE 1-2-2

RBOSC CONSTRUCTION & OPERATION SCHEDULE

2.2 TRACT ACTIVITIES, OCTOBER 1977 - DECEMBER 1978

Table 1-2-1 is a summary of the 1977-78 construction milestones for Tract C-a.

Table 1-2-2 is a list of RBOSC's major contractors and their responsibilities for work on Tract C-a.

Site preparation was initiated in October 1977, after DDP approval, and was accelerated by means of incentives and around-the-clock site clearing for the mining and processing areas and access road preparation. Work was interrupted temporarily at the end of January 1978 during the coldest winter months until mid-May when site preparation was again resumed. The remainder of the site was prepared during the summer and fall of that year, including work on all principal processing areas and retention ponds.

Tract C-a is underlain by two aquifers lying above, in and below the oil shale-bearing strata. In order to develop the tract for recovery of the oil shale resource, it is necessary to dewater the section to be mined. The lower aquifer will not be penetrated by the MDP operations; thus, it is necessary only to dewater the upper aquifer in the affected area.

Initial implementation of the dewatering system began in late 1977 with drilling and pump testing of three wells. Because of pump failures, electrical supply problems and other factors, significant pumping rates could not be established until early in 1978. Even then, continued field problems hindered progress on installation and sustained operation of the dewatering system throughout the first half of 1978. Two additional wells were added to the dewatering system in June 1978. The combined production of the five wells has reached as high as 3,600 gpm, but has gradually declined over time to less than one-half that rate. In July 1978, water inflow to the shaft and drifts was encountered. Water production has varied as new ground has been opened. Flow rates

TABLE 1-2-1

TRACT C-a CONSTRUCTION MILESTONES, 1977-78

	Start	Completion
Administration Building	July 1978	December 1978
Warehouse Building	July 1978	December 1978
Water Treatment Plant Building	November 1977	June 1978
Shaft Water Treatment System	May 1978	May 1978
Potable Water System	May 1978	January 1979
Sewage Treatment System	December 1978	----
Mine Rescue Building	October 1978	----
Generator Building	May 1978	----
Fire Pump House	June 1978	December 1978
Collar Shaft	January 1978	January 1978
Head Frame	March 1978	May 1978
Hoist House	January 1978	April 1978
Mine Mechanics Shop	January 1978	March 1978
Mine Compressor Building	September 1978	-----
Hunt Club Office	April 1978	July 1978
Core Storage Building	April 1978	June 1978
Security Shack - First	January 1978	January 1978
- Second	December 1978	January 1979
Moon Lake Power Line	November 1977	June 1978
Temporary Electrical Distribution	May 1978	July 1978
Permanent Electrical Distribution	September 1978	-----
Site Clearance (Mine & Plant Bench)	October 1977	June 1978
Blowdown Water Retention Pond	May 1978	November 1978
Mine Service Area Retention Pond	May 1978	----
Settlement Pond at Head Frame	June 1978	June 1978
Runoff Ponds	May 1978	May 1978
Runoff Ditches	May 1978	May 1978
Diversion Ditches	October 1978	October 1978
Construction Area Fence	October 1978	----
Process Area Foundations	September 1978	----
Dewatering Wells - D-1	November 1977	January 1978
- D-2	November 1977	February 1978
- D-3	December 1977	February 1978
- D-4	April 1978	June 1978
- D-5	May 1978	June 1978
Reinjection Well Pipelines:		
- GS 4-5	May 1978	June 1978
- TO 2	May 1978	July 1978
- GS 6	May 1978	July 1978
- TO 3	May 1978	August 1978
500,000 Gallon Reinjection Water Tank	December 1977	February 1978
Access Road	December 1977	June 1978

TABLE 1-2-2

TRACT C-a MAJOR CONTRACTORS AND RESPONSIBILITIES, 1977-78

Contractor	Responsibilities
Morrison-Knudsen Company (M-K)	Provide Design Engineering and Project Management
American Mine Services, (AMS)	Shaft Sinking
The Industrial Company (TIC)	General Services Contractor
International Engineering Company (IECO)	Operational Hydrology
Nielsons, Inc.	Site Work
Moon Lake Electric Association, Inc.	Owner of 138 KV Power Line
Wasatch Electric	Construction of North Half of Power Line
Sturgeon Electric	Construction of South Half of Power Line
Ruscon-Becon and Associates (RBA)	Below Grade Construction for Process Facility
Harrison Electric Constructors, Inc.	Below Grade Electrical Distribution
Wright Water Engineers	Environmental Hydrology
NUS Corporation	Environmental Program

are much higher than had been expected. The site-specific transmissivities are an order of magnitude above that applied in model studies made before drilling the first three dewatering wells.

Conversion and testing of existing exploratory coreholes to reinjection wells on a sustained basis was accomplished by May 1978. Sustained injection tests have been made in nine existing holes. Two holes have been eliminated for further consideration because of their low injectivity rates. By July 1978, sustained injection testing to four existing holes had been achieved, and by November 1978, 100% of the dewatering well water produced was being reinjected into the four injection wells. The water produced from shaft development was not reinjected during 1978.

Water has temporarily been discharged down Corral Gulch under an existing NPDES permit during pump testing, during pump failures, and while injection wells were being developed. Water encountered in the shaft during development was also discharged under the permit requirements after being treated. Dewatering well and mine seepage water was monitored prior to reinjection or discharge under terms of the following: the lease, the reinjection and NPDES permits from the Colorado Department of Health, and a proposed augmentation plan that has been given temporary approval by the State Engineer.

The shaft contractor began mobilization in late November 1977. Shaft sinking was started by crane in early January, after obtaining the Prevention of Significant Deterioration permit from the EPA. The shaft was collared in January and from early March to mid-May a headframe was erected and a hoist was installed and checked out. The shaft and station levels were developed during the remainder of the year. By year end the shaft depth was at 638 feet (the planned total depth is 971 feet) and concrete lined to 588 feet. Stations were developed on two levels during the latter half of the year. Excavation on C level station (494-foot depth), including an area for testing future rubblization and blasting, was completed in October. By the end of the year, E level station (604-foot depth) was being mined.

Progress in shaft and station development was hampered greatly by water inflow, H_2S gas, bad ground and severe weather. Water inflow in the shaft began in late July and increased during the year. A pumping system has been installed in the shaft and at both stations for dewatering purposes. Varying levels of H_2S have been detected in the shaft and stations concurrently with the start of water inflow. This led to modification of the ventilation system, again causing delays. Steel sets and timber cribbing have been installed in addition to rock bolts for ground support on the station level. Severe weather and working conditions resulting in absenteeism and labor turnover, have also caused delay in progress.

Construction for the Process Facility foundations and underground piping began in September 1978 and continued through the end of the year. Some time was lost due to problems associated with inclement weather. Process facility equipment began arriving at year end and was being warehoused on-tract. Electrical power for the tract was initially from on-site diesel-driven portable generators. Construction of the north half of a 22-mile long 138KV electric transmission line from Moon Lake Rural Electric Association was initiated in early November 1977, and completed by the end of March 1978. The south half was installed primarily utilizing helicopter construction. This type of construction was used to minimize environmental impacts. The line was energized and started supplying power to tract facilities about mid-June using a temporary distribution system. Work started in October to install a permanent electric distribution system. A permanently mounted 2500 KW generator will be on standby emergency backup to the Moon Lake power.

Three major water treatment systems have been built. A mine seepage water treatment system comprised of a 500,000 gallon water storage tank, water filtering equipment and associated piping was put into operation in July. Construction of a potable water plant and sewage treatment plant was started in 1978. The potable water plant was almost complete and the sewage treatment plant was about half complete at year end. Two retention ponds were built during the year. Because of the unexpected large quantities of water encountered, and the sediment load involved, it is contemplated that one retention pond will be used as a settling pond prior to reinjecting water into the wells. This would lessen the high amounts of sediment that accumulate in the wells during the period of reinjection.

During the reporting period, numerous programs for environmental protection, health and safety were established. An industrial hygiene program covering mining was instituted with the first survey being performed in October of 1978. A general safety and accident prevention program is also in force at the tract. Two ambulances and a fire truck were purchased and are available. Training in first aid and firefighting has been given to employees. Air pollution was prevented or mitigated by dust control and controlled burning of slash. Permanent and temporary revegetation efforts have been started and should be an effective dust control method. Surface soil from the areas cleared for development was stored for reclamation purposes. Information was given to employees and visitors to control human disturbance of the land as part of an environmental management plan. Workers were warned about avoiding certain areas of scientific and historic interest. Car pooling has resulted in less traffic which has reduced automobile kill of deer. Buildings were painted in colors harmonious with the surrounding countryside.

Operational monitoring was performed in the shaft for hydrogen sulfide, methane, carbon monoxide, carbon dioxide and dust. Subsidence monuments were installed in the vicinity of the retorts and monitoring was performed.

Environmental monitoring studies were ongoing throughout the reporting period. Various air quality and meteorology parameters were measured at specified sites beginning in the fall of 1977. Most of the parameters were measured continuously. A joint study on visibility with Tract C-b was run twice during the 1978 calendar year. Biotic monitoring including mule deer and feral horse surveys, color infrared photography, range productivity and utilization studies, and browse condition and utilization programs were conducted. Aquatic ecology studies were conducted five times each year. Physical and water quality measurements were taken and periphyton and benthos were sampled. Ecological study sites were located on Tract C-a, within a 3 mile perimeter of the tract, and on Yellow Creek and the White River. Hydrology studies of surface water, alluvial groundwater and upper and lower aquifers were performed. Physical and chemical parameters were measured in compliance with requirements of lease and permits that were in effect during the year.

Figures 1-2-3 and 1-2-4 are plot plans showing all existing structures or facilities either completed or under construction as of December 31, 1978. Figures 1-2-5 and 1-2-6 are aerial photographs of the main development area at Tract C-a. Table 1-2-3 is a legend identifying the facilities shown on these latter two figures.

2.3 FUTURE ACTIVITIES

In order to assess what part of the injected water, if any, is returning to the mine, RBOSC will perform an injection-recycle test in early 1979. Depending upon results from the test, the injection well system will be enlarged, if required. The future amount of inflow to the mine area and the performance of new injection wells are still unknown.

The shaft is scheduled to be completed during the summer of 1979. At that time, a mining contractor will begin development of the drifts and retorts. The burn of Retort 1, after rubblization and tracer test, is presently scheduled in early 1980. Four other retorts will be sequentially developed and burned during the following 2½ years.

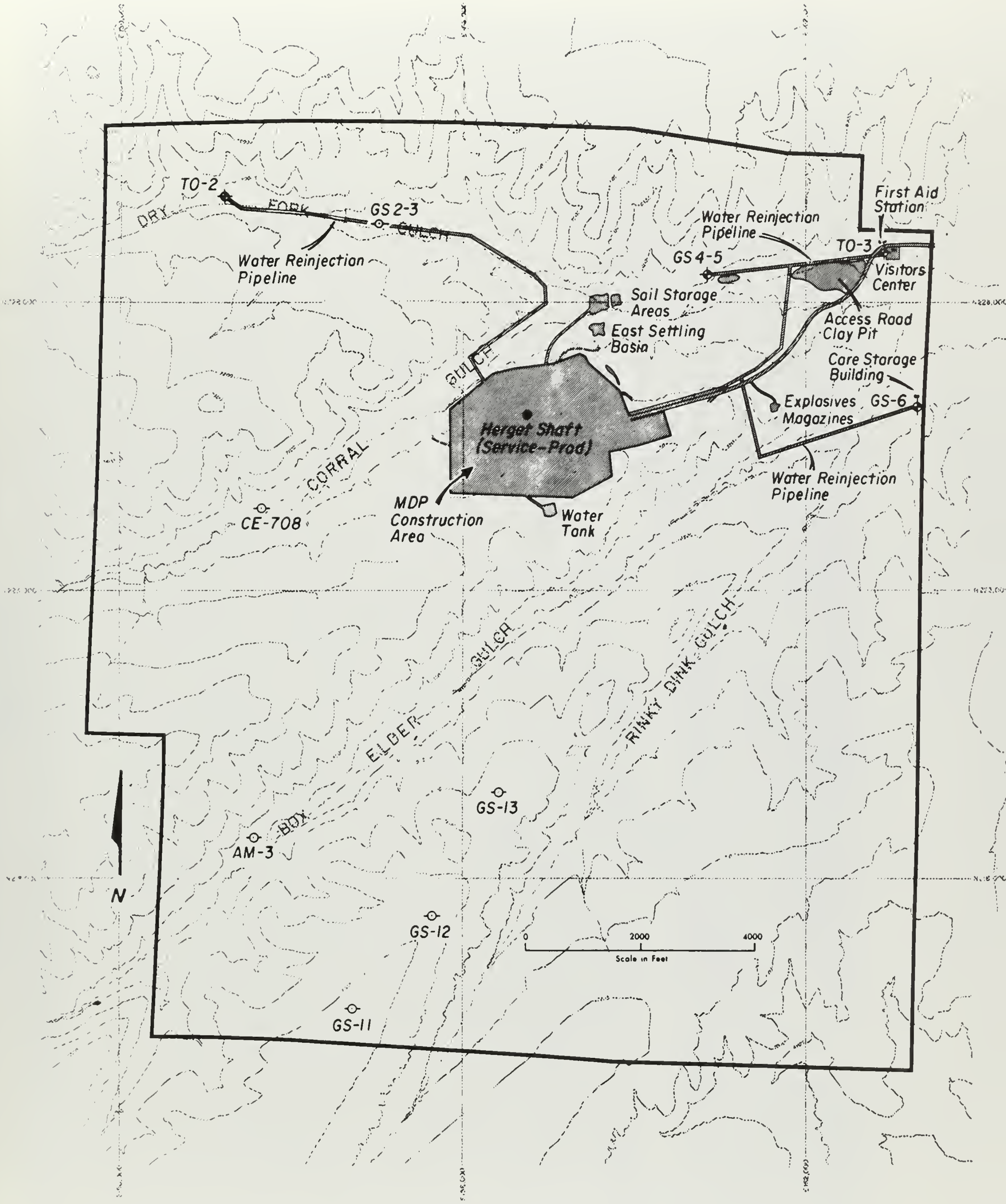


FIGURE 1-2-3
TRACT C-a PLOT PLAN, DECEMBER 1978

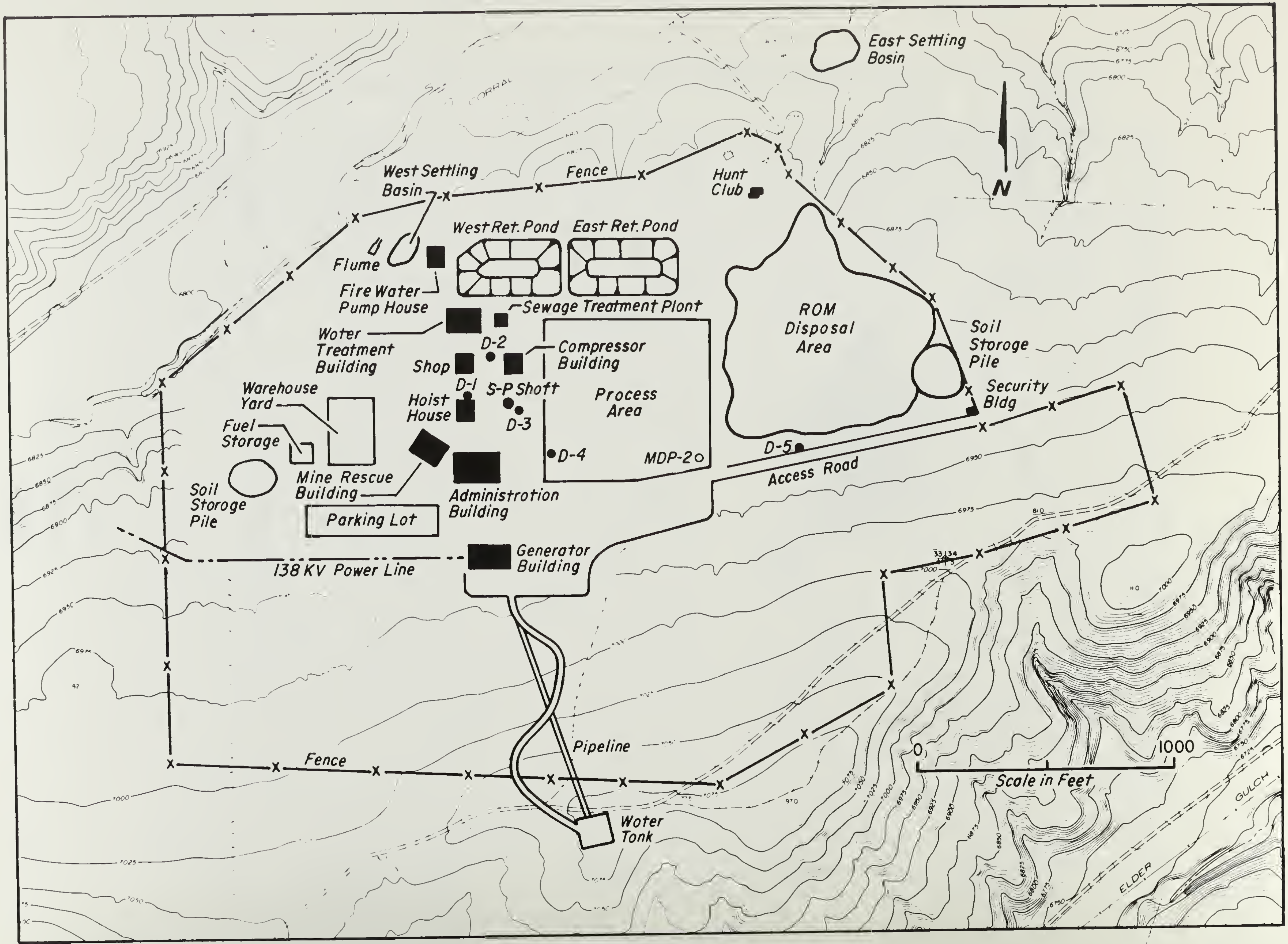


FIGURE 1-2-4
MDP CONSTRUCTION AREA PLOT PLAN, DECEMBER 1978

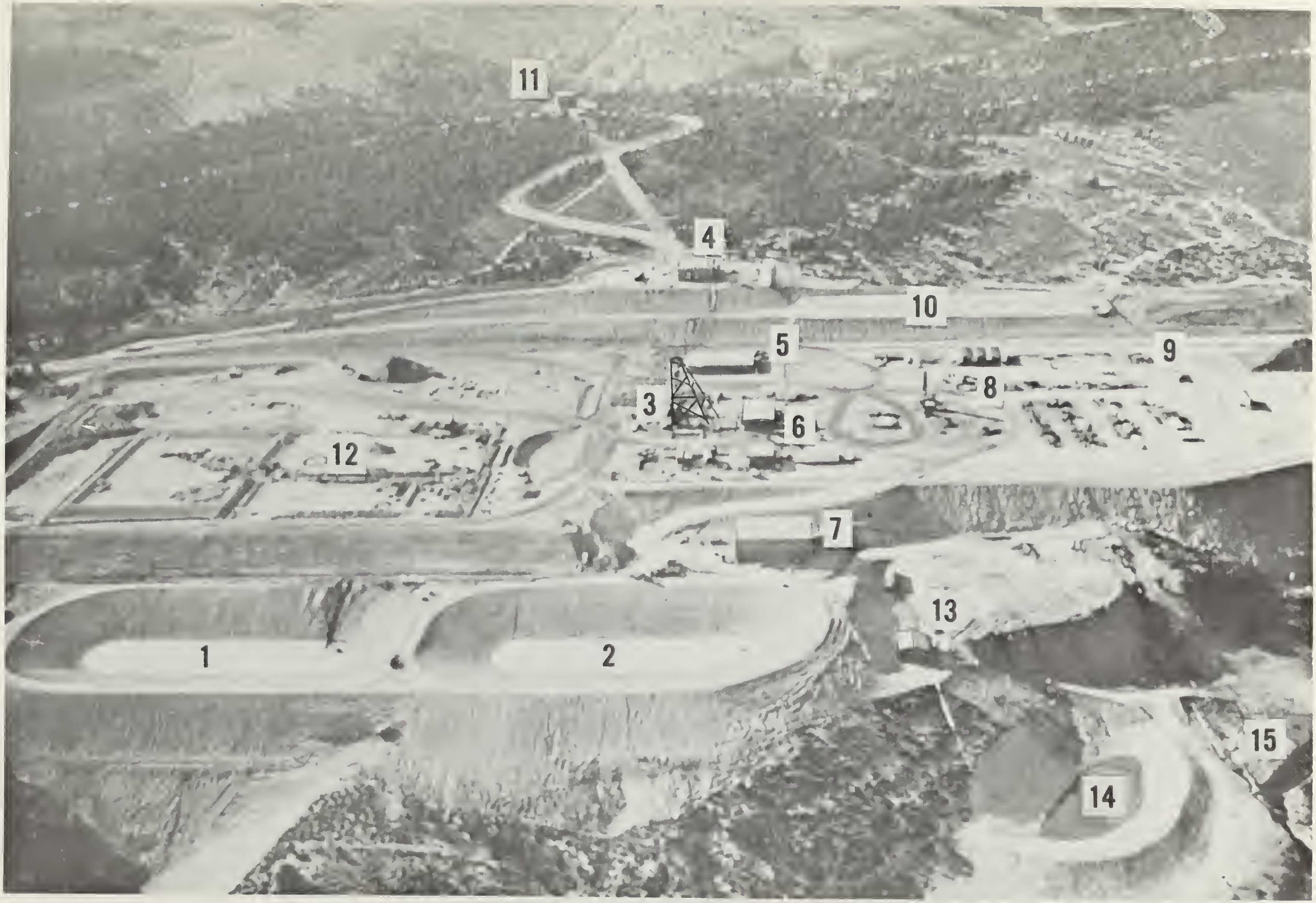


FIGURE 1-2-5
OVERVIEW OF MDP CONSTRUCTION AREA, OCTOBER, 1978

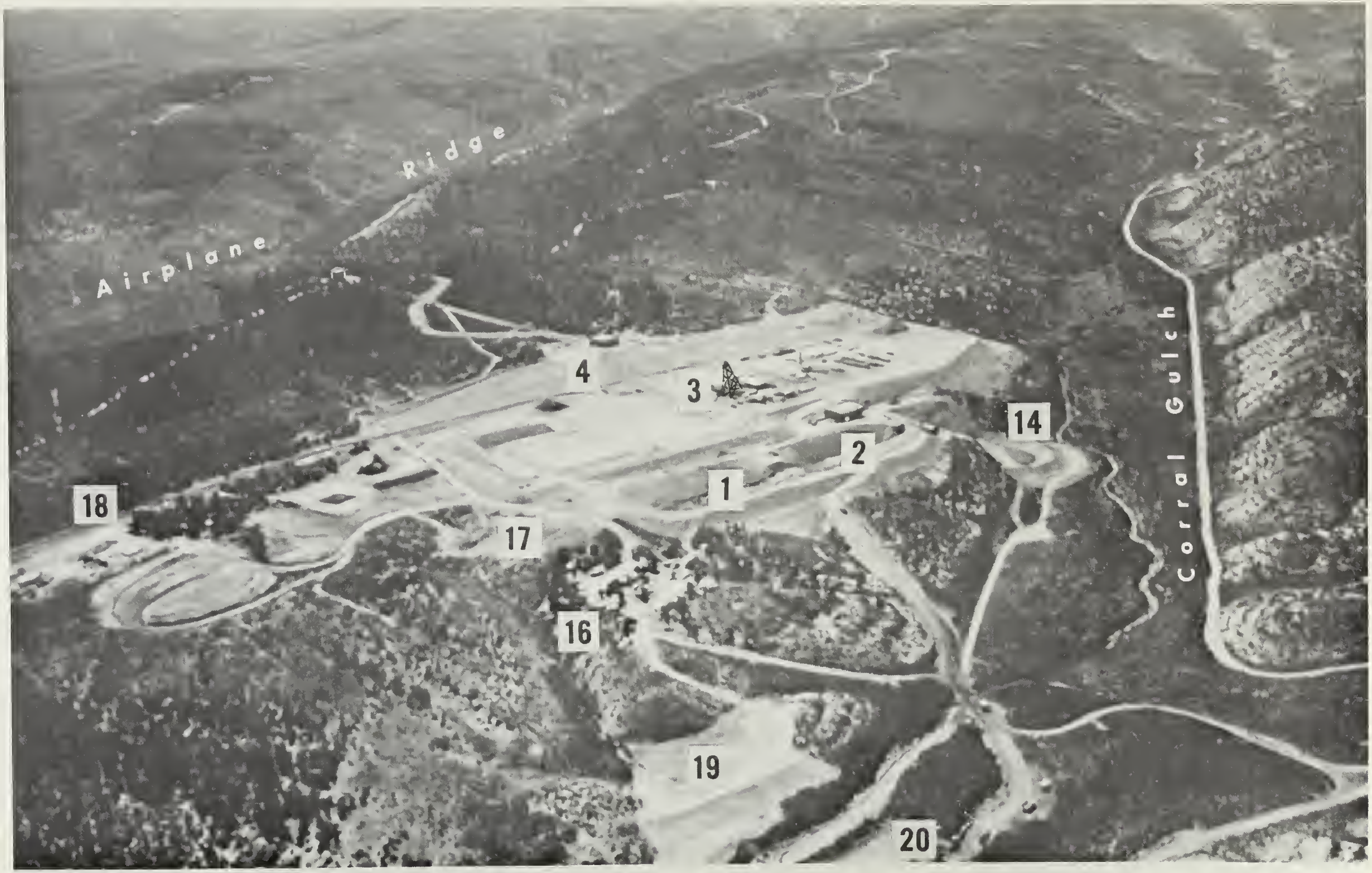


FIGURE 1-2-6

OVERVIEW OF MDP CONSTRUCTION AREA, AUGUST 1978

TABLE 1-2-3

LEGEND IDENTIFYING FACILITIES FOR FIGURES 1-2-5 and 1-2-6

1. East Retention Pond
2. West Retention Pond
3. Shaft Headframe
4. Generator Building
5. Administration Office Building
6. Hoist House
7. Water Treatment Building
8. Warehouse Area
9. Fuel Storage Area
10. Parking Area
11. 500,000 Gallon Water Tank
12. Process Area
13. Firewater Pumphouse
14. West Settling Basin
15. Flume

16 Contractors (Hunt Club) Office Area

17. Run-of-Mine Stockpile
18. Access Road
19. East Settling Basin
20. Clay Pit Borrow Area

The Processing Facility and all other support facilities will be completed during 1979. Environmental protection, health and safety programs will continue during the MDP. Environmental monitoring will also continue in accordance with all lease and permit requirements.

2.4 SOCIOECONOMIC ACTIVITIES

Reports of socioeconomic plans and activities related to tract development are not required by the lease and are not included in the body of this report. Such activities are vital to the C-a effort, however, so a brief summary is provided in this section of the report.

Development of Tract C-a at a production level of 76,000 barrels per day could result in a permanent employment of about 1,500 workers and a total population increase in the region of some 5,800 people. Rangely, Colorado has been projected as the location for the great majority of this growth.

In order to help Rangely accommodate the population increase, RBOSC has invested considerable time and resources in helping the community to develop a Rangely Master Plan. The Rangely Master Plan outlines methods to satisfy additional needs for residential growth, transportation systems, flood protection, water supply, utilities, educational considerations, recreation areas, industrial locations, community services, and agricultural lands. In addition, RBOSC funded the work necessary to update Rangely's municipal code. Also, help was provided to the town to develop a proposal for Rangely to purchase about 2,500 acres of Federal land surrounding Rangely so population expansion can occur. That transaction with the Department of the Interior is not yet complete. The people of Rangely have done a great deal themselves to prepare for oil shale, including the expansion of water and sewer systems, street improvements and construction of a new elementary school and a new recreation center.

However, a key to directing growth to Rangely is the construction of a new road to reduce commuting distance. Current distances from C-a are 68 miles to Rangely, 58 miles to Rifle and 51 miles to Meeker.

Studies made in 1974 and 1975 showed that a new road constructed northwest from the tract to Rangely could reduce commuting distance to about half of any existing route. The most desirable alternative of the ten routes studied appeared to be a 25-mile route originally estimated to cost about $10 million in 1975. In addition to the improved morale and safety factors of a shorter commuting distance for employees, the new road would direct some of the oil shale population expansion away from Meeker and Rifle, the towns most likely to receive the growth from Tract C-b development. A survey taken in all three communities indicated such a road would be favored by the great majority of the people in the area.

Sufficient funds for the road were available in the Oil Shale Trust Fund held by the State of Colorado. Under the terms of the Federal Land Policy and Management Act of 1976, the state where the tracts are located received a portion of the lease bonus payment which may be used to help offset socioeconomic impact. Some $73 million have been placed in the fund by lessees of the two Colorado tracts. Gulf and Standard's lease payments provided Colorado with more than $47 million. The Colorado General Assembly specifies the amount of money allocated from the trust fund and where it will be spent after considering recommendations from the impacted counties.

To date, the legislature has not funded a new road. Part of the reason for its refusal to do so was the one year suspension of operations from September of 1976 to September of 1977 when RBOSC was unable to proceed with tract development. Since that time, the modular, modified in situ development has begun on Tract C-a. However, the decision to proceed with the Commercial Phase is not likely to be made until 1982. This fact has also deterred the legislature from a positive decision on the road.

Since the new road was designed, its projected cost has risen more than one million dollars. This inflationary increase has contributed to a recommendation by local officials to change the route to reduce the immediate construction costs. The revision, recommended to the 1979 General Assembly, is about 10 miles longer than the optimum route and includes a gravel surface but no paving. Projected cost for this route is just over $5 million.

Meanwhile, the 1978 General Assembly approved a $1 million appropriation from the trust fund to improve and pave the existing 13 miles of County Road 24 from C-a east to Piceance Creek Road. This work is underway and will improve conditions for traffic to and from Meeker and Rifle.

RBOSC estimates that peak employment during the 1978-1982 most intense construction period of the modular phase will not exceed 300 to 350 people. That number is likely to be reached in 1979 for only six months. The numbers will drop to between 100 and 150 for most of the remaining period. The last few months will require less than 100 workers. In 1978, the peak number of workers reached 229 in November; by year's end the figure had dropped to about 195.

RBOSC has an agreement with a developer who is constructing mobile home park facilities for Rangely to help mitigate the impact of Tract C-a workers during the MDP. The agreement provides that RBOSC will pay monthly rent for up to 25 mobile home spaces if not occupied during the agreement period. The agreement protects the owner from potential loss of income and provides needed housing facilities for Rangely.

Transportation is furnished to RBOSC and Morrison-Knudsen personnel. The majority of other workers are car pooling. Because most contractors are only working on the tract for a short time, this kind of arrangement appears to be the most practicable, at least until a decision is made to continue with the Commercial Phase.

2.5 REGULATORY REQUIREMENTS

The Tract C-a lease requires the lessee to comply with all applicable federal, state and local statutes, regulations and standards that are in existence during the course of our operations. To date, RBOSC has had more than 130 regulatory requirements processed through 18 government agencies. Some of the permits were major in character requiring considerable time and effort by both RBOSC and the reviewing agencies, especially those permits that show compliance with environmental quality and safety standards.

A Prevention of Significant Deterioration (PSD) permit was issued by the EPA on December 15, 1977 after public comment and hearing. This allowed RBOSC to begin its construction activities on the tract which began with sinking the shaft. A New Source Construction Permit (air emissions permit) for the MDP facilities was obtained from the Colorado Department of Health (CDOH), Air Pollution Control Division, in June 1978. The CDOH Water Quality Control Division issued a discharge permit (NPDES) to RBOSC in September 1977. An amended permit was issued the following month. This covered temporary discharge of water while testing and drilling dewatering and injection wells. Prior to reinjecting water into the aquifer, RBOSC obtained a Subsurface Disposal Permit from the Water Quality Control Division in May 1978. This was preceded by public hearing on the permit application. The permit allows reinjection until the burn of the first retort.

A reclamation permit was obtained from the Colorado Department of Natural Resources' Mined Land Reclamation Board in March 1978 following a public hearing held two months earlier. In December 1978, RBOSC consummated an agreement with the Colorado Division of Wildlife (DOW) for purchasing a parcel of land designated by the DOW in exchange for 534 acres on Tract C-a in which the DOW owned the surface and non-oil shale mineral rights. RBOSC paid $534,534 for this exchange. In May of 1978, RBOSC requested a modification from the Mine Safety and Health

Administration to the mandatory standard 57.4-58 which states "Fires shall not be built underground;...". This variance will be necessary to allow underground combustion of in situ retorts. A Special Use Permit was obtained from Rio Blanco County in November 1978.

In 1975, RBOSC went before the Colorado Water Court, Division 5, seeking judicial determination of its rights to dewater the areas to be mined for oil shale and to appropriate water for beneficial use. In June 1977, the Water Court determined that RBOSC has the right to dewater the mine or mines to be constructed on Tract C-a. The Court recognized that injurious effects which might otherwise occur can be mitigated by reinjection into the aquifer of water produced from dewatering and by certain other mitigating measures stated in the Court order.

2.6 ANNUAL PROGRESS REPORT (APR) ORGANIZATION AND USE

RBOSC's APR was written and organized to closely follow the organization of the DDP of May 1977. All section titles of the APR are the same as the DDP except Section 7 which combines Sections 7 and 8 of the DDP. By referencing the section number and title, the reader can refer to the DDP for additional information on the plan being implemented.

The DDP presented RBOSC's plan of action. This progress report tells what has occurred on Tract C-a since operations commenced after DDP approval through the end of 1978. Where deemed useful for continuity, some sections contain very brief summaries of the concept described in the DDP and some information on future plans. Also discussed in the APR are approved changes that have been made as a result of engineering and operational evaluation.

A 3-digit page numbering system is used throughout the APR. Page numbers are keyed to the chapters within the section; page 5-3-4, for example, refers to Section 5, Chapter 3, page 4. A similar system is used for figure and table numbers.

SECTION II

MINING

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

The DDP provided a background of basic data, described mine geometry and related facilities, and summarized the activities required to (1) develop access to the MIS retorts; (2) rubblize these retorts; and (3) develop passageways for moving retort products (gas, oil and water) to the surface. Details have been developed and are continuing to change as a result of detailed design refinement and ongoing evaluation. This chapter provides brief background information on the site description, geology, hydrology and rock mechanics. Chapter 2 contains information on the shaft development and Chapter 3 briefly touches upon mine design and the upcoming mine development.

1.2 SITE DESCRIPTION

The site selected for the five retorts of the MDP is just north of the center of the tract. The entire MDP area is within the shaft pillar of the commercial shafts. This is the area that would be unaffected by any unplanned subsidence of the retorts. Figure 2-1-1 illustrates the relationship of the MDP features relative to the commercial retorts.

1.3 GEOLOGY

The oil-shale interval being developed is in the Parachute Creek Member of the Green River Formation of Eocene age. The shales are exceptionally well-bedded and individual stratigraphic units can be traced accurately over many miles. The interval is subdivided into rich and lean zones, closely following a system developed by the US Geological Survey. Figure 2-1-2 is a cross section through the Herget Shaft (service-production) and the five retorts of the MDP.

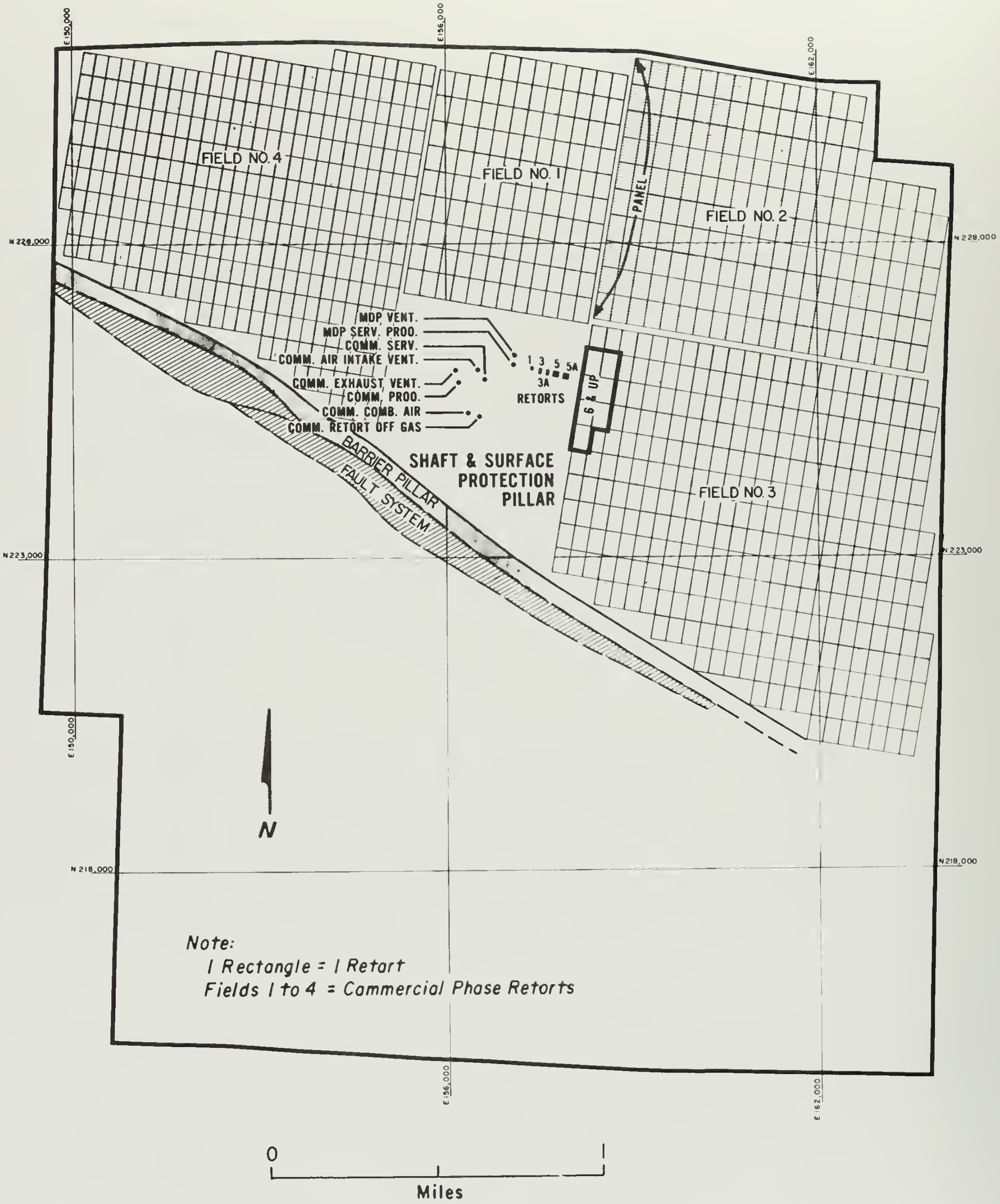


FIGURE 2-1-1

GENERAL TRACT LAYOUT

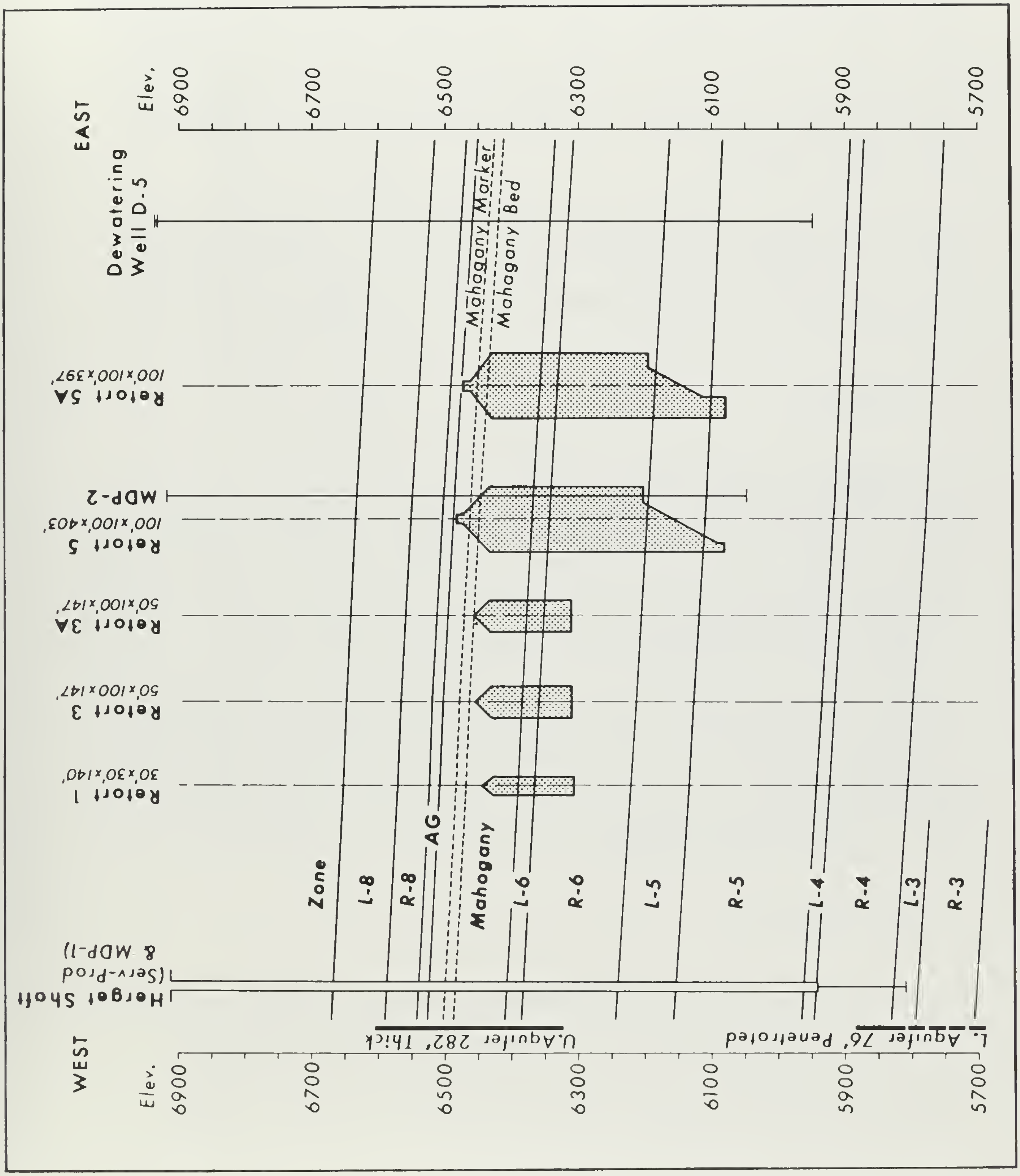


FIGURE 2-1-2
GEOLOGIC CROSS SECTION THROUGH HERGET SHAFT AND FIVE MDP RETORTS

The oil shales are dominantly marlstones containing varying amounts of kerogen (organic matter). The amount of oil yielded by a given shale interval by Fischer Assay, a standard laboratory retorting procedure, is given in US gallons per short ton. The highest grades encountered on Tract C-a are in the range of 80 gallons per ton (in thin beds) and the average grade of the resource is about 23 gallons per ton (Commercial Phase retort interval).

Several northwest-trending graben (fault systems) transect the tract. All of the retorts of the initial forty years of commercial production lie to the north of the northernmost of these graben, as illustrated in Figure 2-1-1.

1.4 HYDROLOGY

All groundwater found below the level of the alluvium on Tract C-a is within two aquifers. The uppermost of these is a fractured aquifer averaging about 200 ft. thick and carrying water containing about 900 ppm total dissolved solids. The mine workings of the MDP are largely within the upper aquifer and the aquitard separating the two aquifers.

The lower of the two aquifers is made up of both fractures and solution cavities and is the more uniformly permeable of the two. This aquifer averages about 200 ft. thick and its water contains about 1100 ppm total dissolved solids. The mine workings of the MDP are designed to be totally above the lower aquifer.

1.5 ROCK MECHANICS

The determination of mechanical properties of the oil shales on Tract C-a is required to provide a basis for the design of ground support to enable the prediction of subsidence and to assist in the design of optimum rubblization methods. Selected intervals of core from the original exploration corehole program have been tested at ambient temperature for the following:

- Uniaxial compressive strength
- Modulus of elasticity
- Tensile strength
- Angle of internal friction
- Cohesion
- Rock density
- Shear strength
- Modulus of rupture
- Poisson's ratio
- Shear strength of rubble material

More recently, laboratory measurements of the effect of elevated temperatures on core samples have been performed.

A program for the measurement of in situ rock properties in the pillars between and rocks overlying the retorts of the MDP has been developed. This program will be implemented as the mine develops and will monitor rock behavior prior to, during and after retort rubblization. It will further provide data on stress and strain near the retorts during and after the burns of the MDP retorts. All of this information will provide a more rational basis for the design of Commercial Phase retorts.

CHAPTER 2
SHAFT DEVELOPMENT

2.1 INTRODUCTION

Site preparation for the mine and plant bench was started in late 1977 and completed during the first half of 1978. During that time, the following quantities of soil and rock were handled.

- Plant and mine bench final excavation - 460,000 cu. yds.
- Quantity of surface soils stockpiled - 31,303 cu. yds.
- Plant site embankment - 440,000 cu. yds.
- Number of acres worked (mine and plant bench) - 47 acres.

In November 1977, RBOSC selected American Mine Services, Inc. (AMS) of Denver, Colorado to sink the 15 ft. diameter service-production shaft to a depth of 971 ft. AMS began mobilizing immediately after being awarded the contract and began shaft sinking by crane on January 7, 1978. After reaching a depth of 60 ft., the shaft was officially collared on February 2, 1978 and designated the Herget Shaft in honor of RBOSC's first president, Walter T. Herget. Shaft sinking was discontinued while a headframe and hoist house were built and checked out from March to May 1978. Shaft sinking was resumed on May 13, 1978.

Figure 1-2-1, an isometric view of the planned MDP mine development, shows the station levels discussed in this chapter. Table 2-2-1 shows 1977-1978 milestones in the Herget Shaft sinking operation.

2.2 DEVELOPMENT METHOD AND ROCK HANDLING

The shaft is being sunk by conventional drill/blast/muck methods and lined with a minimum one-foot thickness of concrete as sinking progresses. Two 4-ton buckets are loaded by an air-operated Cryderman mucking machine.

TABLE 2-2-1

1977-78 MILESTONES IN HERGET (SERVICE-PRODUCTION) SHAFT SINKING OPERATION

Milestone	Date
Corehole MDP-1 (center of Herget Shaft)	October 1977 to November 1977
Contract award to AMS	November 1977
Start mobilization	November 1977
Start excavation of shaft collar	January 1978
Collar the shaft	January 1978
Install headframe	March 1978 to May 1978
Install hoist house	February 1978 to May 1978
Start conventional sinking	May 1978
Install shaft ventilation system	June 1978
Water encountered in shaft	July 1978
Install shaft dewatering pumps	July 1978
C level station development	August 1978
E level station development	November 1978

Shaft Depth Progress	Shaft Depth	Concrete Depth
Month ending May 1978	140'	118'
Month ending June 1978	314'	296'
Month ending July 1978	471'	458'
Month ending August 1978	530'	498'
Month ending September 1978	530'	498'
Month ending October 1978	606'	578'
Month ending November 1978	638'	588'
Month ending December 1978	638'	588'

As one bucket is hoisted to the dump station in the headframe, loading of the second bucket is started immediately.

A four-deck Galloway stage (a work platform) provides access to the shaft walls for moving the concrete slip-form and for installing shaft steel. The slip-form behind which the concrete for lining is placed is 20 ft. long, the maximum length of a pour. It is segmented so that shorter pours may be made if "bad ground" dictates. Concrete is placed from the surface through a pipe to the Galloway. From there it is directed to pour doors in the forms.

Blastholes are drilled vertically 8 ft. deep at one side of the shaft and progressively shorter to the other side of the shaft. This pattern leaves a sloping bench after the blast and gives an average 4 ft. of advance with each shot. Drilling is with hand-held pneumatic, percussion, sinker drills.

Tonnage and blasting data by quarter for 1978 were as follows:

Quarter	Material Removed (Tons)	Number Blasts	Quantity Blasting Powder (Pounds)
1st 1978	3,087	23	3,000
2nd 1978	5,189	62	6,200
3rd 1978	10,211	223	18,065
4th 1978	5,283	108	11,605

A typical set-up for sinking a shaft is shown in Figure 2-2-1. Figures 2-2-2 and 2-2-3 show the headframe and hoist house, respectively. Figure 2-2-4 shows the batch plant for mixing the concrete used in the shaft. This is located in close proximity to the shaft.

2.3 GEOTECHNICAL DATA GATHERING

Two additional coreholes (MDP-1 and MDP-2) have been completed in the site-specific MDP mine and retort area, one at the Herget Shaft (service-

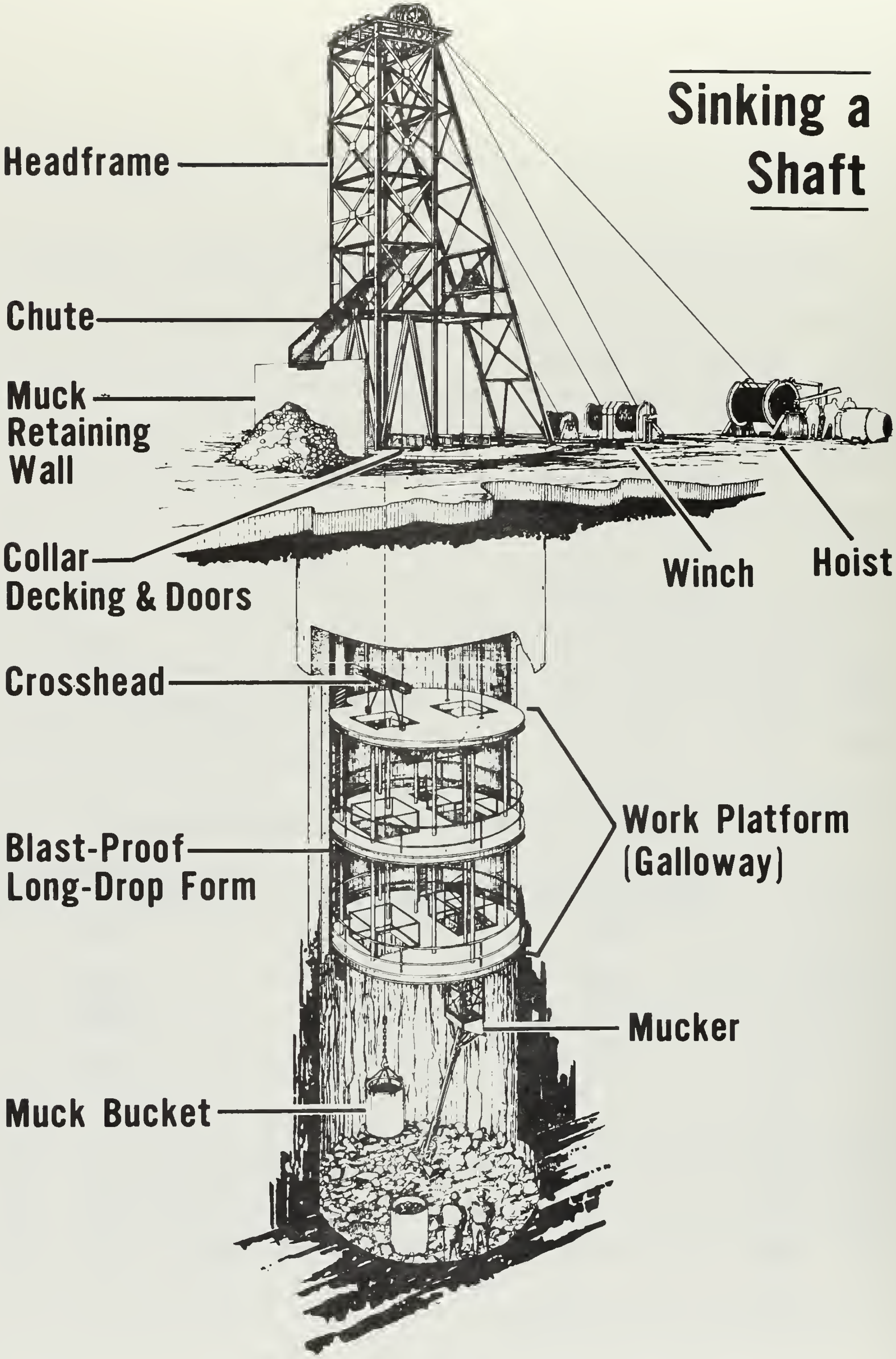


FIGURE 2-2-1

TYPICAL SETUP FOR SINKING A SHAFT

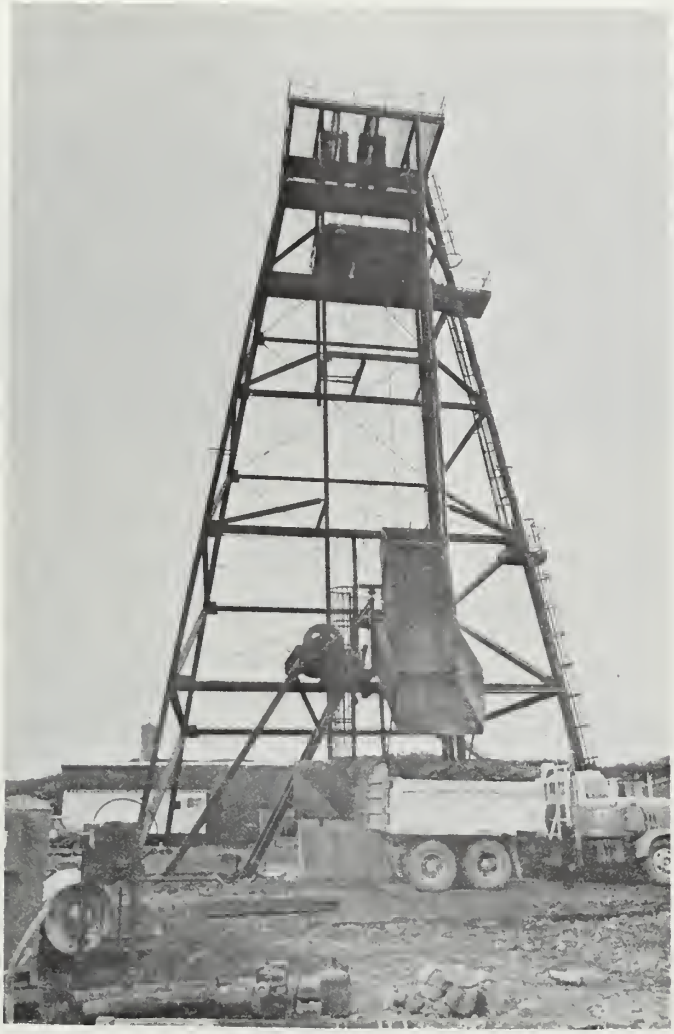


FIGURE 2-2-2
HEADFRAME

production) and the other near the planned location of Retort 5. MDP-1, at the Herget Shaft, was drilled to a total depth of 1104 ft. MDP-2, at Retort 5, was drilled to a total depth of 872 ft. The locations of these coreholes are shown on Figure 5-3-7. Data obtained from these coreholes further defined the subsurface structure, stratigraphy and oil-shale resource within the MDP area.

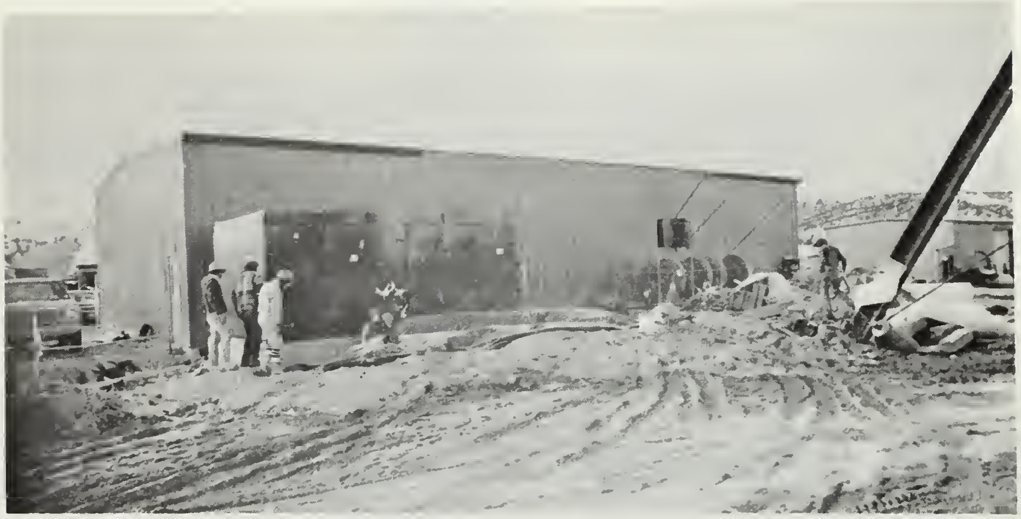


FIGURE 2-2-3
HOIST HOUSE

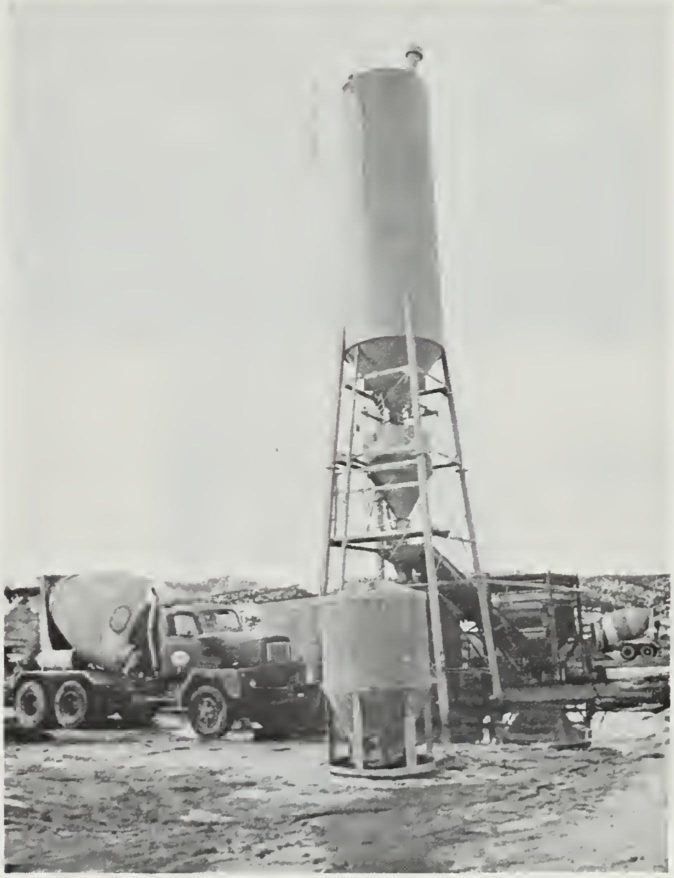


FIGURE 2-2-4
AMS BATCH PLANT

Selected core samples from both coreholes are being tested to provide rock-mechanics parameters applicable to both mine and in situ retort design. Twelve core intervals from the corehole near Retort 5 were collected for detailed measurement of methane gas content, both in the free state and as liberated by crushing. This same corehole is currently being used to monitor upper aquifer water levels as the dewatering program progresses.

As the Herget Shaft and various mine levels are developed, additional subsurface geologic control is being compiled pertinent to mine stability, groundwater flow and blasthole patterns, the latter as applicable to optimum in situ retort rubblization. Joint patterns, faults, "bad ground" and water entry are being mapped.

2.4 SUPPORT OPERATIONS

A. Ventilation - A short ventilation tunnel joins the Herget Shaft just below the collar and above the safety doors to the surface. Currently ventilation is provided by a 150-hp axial flow type fan mounted vertically on the surface directly above the opening at the far end of the ventilation tunnel. This delivers a nominal 50,000 cfm. The fan is enclosed in a corrugated metal pipe cover mounted vertically to ensure air intake is high enough above the ground to avoid recirculation of hydrogen sulfide and to reduce fan noise around the collar. Two 2,000,000 Btu/hr. air heaters feed smaller corrugated metal pipes which manifold into the large one covering the fan to temper ventilation air in cold weather.

B. Shaft/Mine Drainage - Water was first encountered in the shaft at the end of July 1978 at a depth of 471 feet. Water inflow to the shaft has been higher than anticipated. Inflow to the shaft would be substantially higher were it not for five dewatering wells in the mine area. These are described in more detail in the water management section (Section 5, Chapter 3). The range of water inflow to the shaft, by month was as follows:

Month (1978)	Range (Gallons Per Minute)
August	0 - 330
September	300 - 760
October	340 - 600
November	300 - 460
December	540 - 940

C. Power - Electrical power is supplied via the 22-mile long 138-kilovolt Moon Lake Electric Association transmission line through a temporary substation as explained in Section 5, Chapter 2.

The temporary mine electrical distribution system in generalized form is shown in Figure 2-2-5. Two 4160-volt lines carry power to an underground substation on C level. The 500-KVA transformer is loaded to capacity. The second 300-KVA transformer is in reserve and will be utilized for a second ventilation fan planned for installation just above C level.

The mine hoist is driven by two 400 hp, 2300 volt motors. Power is supplied from the Moon Lake substation through a transformer. Two 500-KVA diesel-driven generators are available for emergency power in the event of a failure in the Moon Lake system. These two generators can handle the hoist, the ventilation fan and part of the pumping system.

D. Safety - The general policy, practices and programs for mine health and safety are discussed in Section 6, Chapter 2, Health and Safety.

During normal shaft-sinking operations, hydrogen sulfide (H_2S) gas was first encountered in August 1978 when the shaft was at a depth of about 500 ft. As mentioned elsewhere in this report, water was encountered in the shaft at a depth of 471 ft. Associated with the water, traces of H_2S were initially found. With increasing depth and increased water inflows, the H_2S inflow also increased. It is believed that the H_2S is dissolved in the water and is released as it cascades down the shaft and in the station levels. On several occasions, evacuation of the miners

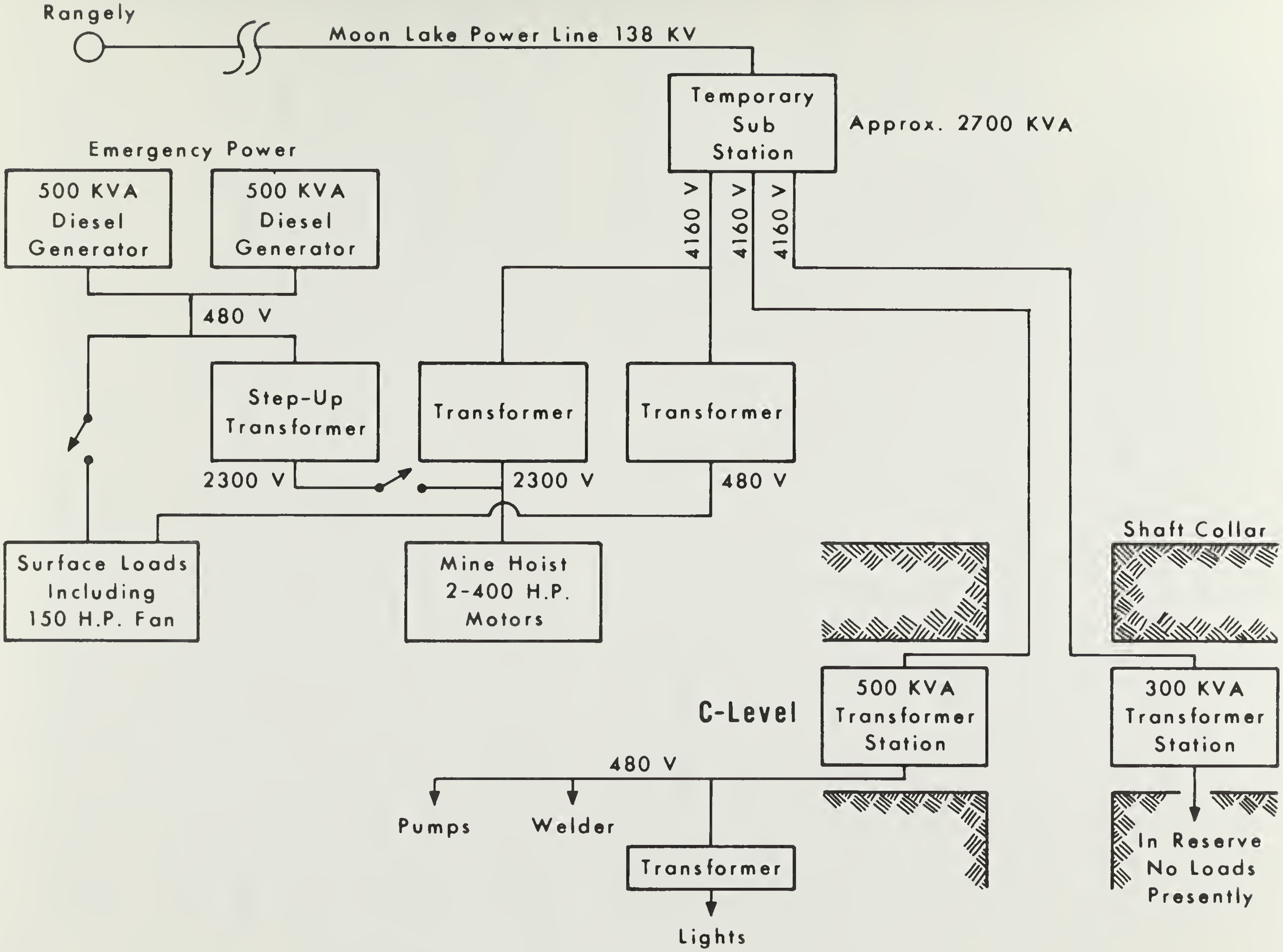


FIGURE 2-2-5
MINE ELECTRICAL POWER

was necessitated by H_2S exceeding the Threshhold Limit Value (TLV) of 10 ppm for eight hours of exposure or 14 ppm for short-term exposure. The initial 11,000-cfm main sinking fan was replaced with a 50-hp fan delivering about 22,000-cfm to the shaft bottom. Eventually, this fan was replaced with a 150-hp fan which now delivers about 50,000-cfm at 10 inches of water gauge.

A continuous H_2S monitoring system was installed in the shaft and hung from the Galloway. In addition, portable hand-operated instruments are used by both the shaft-sinking contractor's walker and also by the construction manager's shaft inspector. The continuous monitor, however, was repeatedly rendered inoperative because of both moisture in the shaft ventilation air and blasting concussion. Consequently, the continuous monitor was moved to a shaft collar location. Since the move, the instrument has functioned satisfactorily after the alarms were adjusted to allow for the dilution of H_2S in the total mine exhaust air. The range of the instrument, which had to be adjusted at the factory, is now 0 to 20 ppm. Several other hand-held H_2S instruments were tested with limited success.

Methane (CH_4) gas was thought to be detected initially In June 1978. It was found, however, that the two methanometers purchased by Tract C-a were faulty. Other instruments were obtained from an alternate methanometer manufacturer. Traces of CH_4 were detected in September 1978 when the shaft was just below C station or about 530 ft. deep. During the remainder of 1978, occasional traces of CH_4 were detected but the CH_4 concentrations encountered neither presented a problem nor caused standby time for the shaft-sinking crew during 1978. A continuous methane monitor was also installed in the shaft on the Galloway but was found unreliable. It was moved to the shaft collar and reset to a range of 0 to 2.5% CH_4. It is now operating satisfactorily.

M-K quality control shaft inspectors and AMS personnel have been checking the shaft hydrogen sulfide and methane at the beginning of each shift, during the shift, and on reentering after each blast. Also, M-K shaft inspectors were notified whenever ventilation changes were made and the inspectors monitored the effects of these changes. Frequent tests are made for carbon monoxide and oxides of nitrogen. As yet no difficulty has been experienced with the other gases.

E. Communications - The hoist is signaled by a bell cord which actuates a Klaxon and light at the various levels. The bell signals generally follow standard Colorado mining practice and are posted at the shaft collar, in the hoist room and on the mine levels. A second signal system has recently been installed to call for the bucket. Voice communication between the hoistman, the collar, C level and the Galloway stage has been installed. Because of wetness of the mine, some difficulty has been experienced in keeping the voice communication system working at all times. Initial difficulties of electrical interference between this system and the continuous gas monitoring system is being studied. A considerably more elaborate communication system is planned for the mine after the shaft-sinking contract is completed.

F. Instrumentation - The continuous recording methanometer and continuous recording hydrogen sulfide meter have been described in Part D above.

A seismometer is installed in the hoist house with two geophones located on the wall of the shaft, one 40 ft. below the collar, the other 440 ft. below the collar. It is actuated automatically by each blast. The two purposes which it serves are to provide a record of the intensity of seismic disturbance caused by blasting and to provide a record of the seismic character of the successive rock strata as the shaft is deepened.

CHAPTER 3
MINE DEVELOPMENT

Most of the design engineering for development of the MDP mine underground workings was completed by September 1978. Upon completion of engineering, a competitive bid process was employed to select a qualified contractor to perform the work. The contractor is currently scheduled to mobilize by midyear 1979. Completion of mine development work by the contractor is scheduled for midyear 1981.

Mine openings will be laid out to support the construction and burn of five retorts as shown on Figure 1-2-1. The largest retort will be 100 ft. square by 400 ft. high. Mine service and rock hoisting will be through the Herget Shaft. Drifts on the main access levels, designated C, E, and G, will be 16 ft. by 10 ft. high and laid out in parallel pairs to provide coursed ventilation. Intermediate levels, designated A, B, D, and F will be developed from ramps and ventilated by auxilliary fans and ducts. The main ventilation fan will be mounted over the future 10-ft. diameter ventilation-exhaust (V-E) shaft and capable of 270 MCFM at 5.6 inches of water gage.

SECTION III

PROCESSING

CHAPTER 1
MDP DESIGN

1.1 DESIGN BASIS

Detailed engineering of the Processing Facilities for the five MDP retorts was over 95% completed during 1978. Several changes in design basis occurred as the work progressed and as new information became available.

The following revisions to the DDP are discussed briefly:

- Modification of the double-alkali sulfur dioxide scrubber to a single alkali scrubber. The sodium sulfite solution from the single alkali system will be solar evaporated in a plastic lined pond;
- The oil/water settlers for the liquids pumped from the underground separator were eliminated. The slower rate of production from the smaller plant will allow settling to take place in the storage tanks;
- Sour water will be pumped to a plastic lined solar evaporation pond instead of to the incinerator. Solid residue will be enveloped in plastic and buried at adequate depth at the end of the MDP;
- The API separator for treatment of oily runoff water has been replaced with an oil skimmer on the retention pond;
- Natural gas became available as process fuel replacing low sulfur fuel oil.

1.2 PROCESS FACILITY DESCRIPTION

Figure 3-1-1 is a flow diagram of the MDP Retorts 1 through 5. The air compressor and the steam boiler will supply a mixture of air and steam to the retort, probably in stages, until the full design rate for each

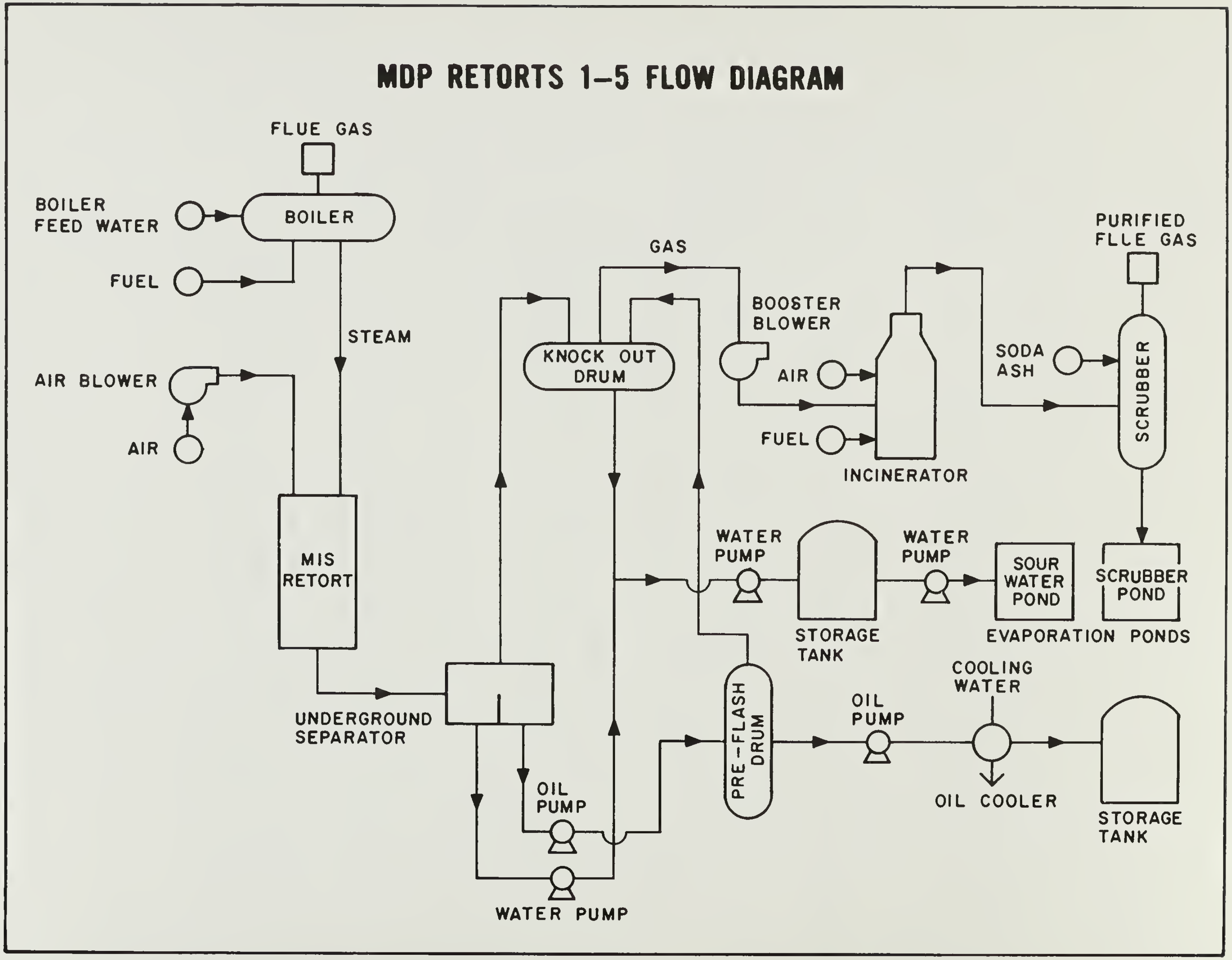


FIGURE 3-1-1
MDP RETORTS 1-5 FLOW DIAGRAM

retort has been achieved. The ratio of air to steam will be varied to control temperatures as the fire front progresses downward through the alternating rubblized lean and rich layers of oil shale. Condensed liquids and low Btu gas flow out of the bottom of the retort to an underground oil/water separator. The separator is designed to allow gravity separation of oil and water before they are pumped to the surface. The oil is pumped to a preflash drum and then through a cooler before being sent to storage. The water flows to a sour water tank and then to a solar evaporation pond.

Gas from the underground separator flows to the surface through an off-gas shaft to a knockout drum before it reaches the suction of the low Btu gas booster blower. The booster blower allows the location of the zero pressure point in the retort to be varied as needed. The retort can be kept entirely under positive pressure or negative pressure or a mixture of positive and negative pressure as dictated by retort integrity. In addition the booster blower supplies the operating pressure for the incinerator/scrubber. The conventional gas-fired incinerator will convert all sulfur species of any form that are in the low Btu gas to sulfur dioxide. The sulfur dioxide is then scrubbed from the flue gas by reaction with a sodium solution to form sodium sulfite. The scrubber is designed to remove 90% of the sulfur dioxide from the flue gas before it is emitted to the atmosphere. The sodium sulfite solution is sent to a plastic-lined evaporation pond for disposal.

Plans are being made to study the low Btu gas stream and the sour water stream through small pilot plants during operation of the MDP Retorts 1-5. The small pilot plants will provide the data needed for the design of Commercial Phase gas utilization and sour water treatment equipment.

The expected maximum rate of production of oil from the MDP Retorts 1-5 is about 800 barrels per stream day. The total amount of oil calculated to be produced during the MDP is about 140,000 barrels. Some of the oil will be used in refining studies leading to commercial design. The oil will be trucked from tract C-a at periodic intervals during the MDP.

1.3 PROCESSING EMISSION CONTROL

During 1978, plans for the supplemental fuel supply during the MDP were changed from fuel oil to natural gas. Fuel is needed to supply steam for in situ retorting and for various process uses including steam tracing and operation of pollution control equipment. Some fuel may also be required to ensure complete incineration of the gaseous products of retorts in the gas cleanup facilities. The change will result in minor reductions in emissions from the steam boiler and incinerator-scrubber stacks.

Detailed design has shown that emissions produced from the retorts described in the DDP allow for lower stack heights. Stack heights have been lowered from 100 meters to 60 meters for the incinerator-scrubber and to 30 meters for the steam generator. Modeling studies have shown that significant reductions in emission rates for the smaller scale of operation allow the reductions in stack height without significantly affecting environmental quality. A modification of RBOSC's PSD permit, including the reduced stack heights, is being reviewed by the EPA.

1.4 RETORT ABANDONMENT

Studies of the slurry-filling technique as a means for providing stable, impermeable spent in situ retorts in future operations were continued. RBOSC contractors are pursuing various aspects of slurry filling, following up on earlier work. Two US patents were issued during 1978 for slurry backfilling of in situ retorts. A proposal was submitted to the US Bureau of Mines to support future studies on a larger scale.

CHAPTER 2
PROCESSING FACILITY CONSTRUCTION

Ruscon, Becon and Associates (RBA) was awarded the below-grade-level construction contract for the process facility's concrete foundations, underground piping and electrical distribution ducts. RBA commenced field work in September and completed 45% of the work by the end of the year. Approximately 5700 tons of material were excavated for the process facility without the use of explosives. This phase of construction is currently scheduled to be completed by April 1979. Figure 3-2-1 shows part of the process facilities foundations under construction.

In December, the aboveground construction bid package for the processing facility was approved for release to bidders. The contract will be awarded in March 1979 and an intensive construction effort will begin in April on the erection of surface facilities. The completed surface plant is scheduled to be ready for operation by year-end 1979.

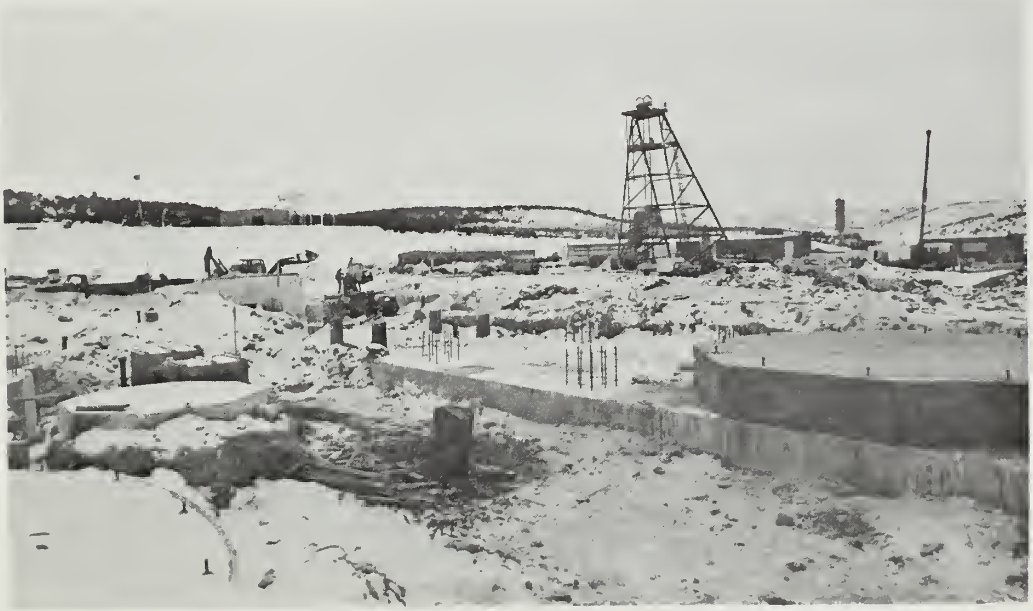


FIGURE 3-2-1
PROCESS AREA

Small process equipment is being stored in a fenced area of approximately 10,000 square feet in the mine service area west of the Mine Rescue Building. This area and an adjacent unfenced lay-down area are easily accessible by truck. Five vans are in the fenced area for dry storage, and one forklift is on site to move equipment.

By the end of the year, portions of the process switch gear, water treatment feeders, incinerator mortar, and numerous pumps, valves and instruments had been received. Essentially all of the process equipment is currently scheduled to be delivered by March 1979.

SECTION IV

ORE DISPOSAL

CHAPTER 1
DEVELOPMENT ORE DISPOSAL

The run-of-mine (ROM) ore disposal area is located just east of the process area as shown on Figure 1-2-4. The approximate 15 acre area has been cleared of surface vegetation. Shaft rock is being moved to the storage area by the shaft-sinking contractor in a 10-ton dump truck and in a 4-cubic-yard front-end loader.

The shaft rock is being spread in the top-of-the-gulch disposal area in 2-ft. thick lifts by the project general services contractor. When the 2-ft. lifts accumulate a 10 to 15 ft. high bench, the next disposal area bench is started at the toe of the constructed bench. Over the four-year MDP program, a total of approximately 450,000 tons of hoisted raw shale will be placed in the disposal area.

A retention pond, sized for a 100-year precipitation event, has been constructed downhill from the disposal area to collect water which moves through the oil shale. Any water which gathers in this pond will be solar evaporated. Isolation drainage ditches separate the ROM area from the natural drainage.

Numerous samples of oil shale are being collected from the shaft rock ore disposal area for testing purposes. Most of these bulk samples are collected in 55-gallon steel drums which are then sealed for shipment. The uses for the samples are discussed in Section 3, Chapter 1.1 and Section 6, Chapter 2.4.

Figure 4-1-1 is a picture of the development ore disposal pile.

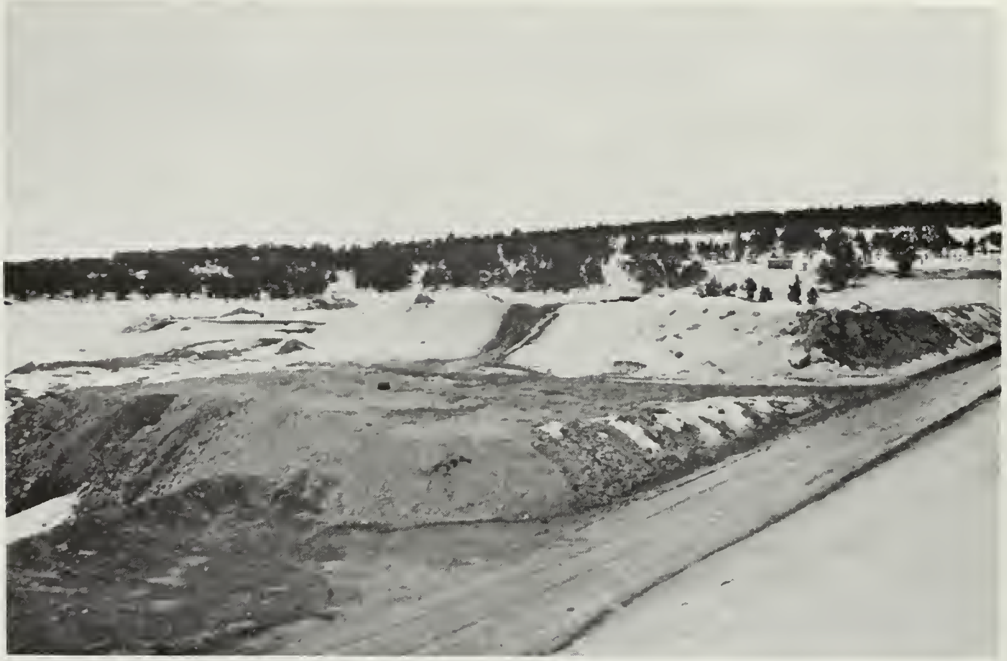


FIGURE 4-1-1

DEVELOPMENT ORE DISPOSAL PILE

SECTION V

SUPPORT FACILITIES

CHAPTER 1
TRANSPORTATION

Figure 1-1-1 shows Tract C-a relative to the major cities of Denver, Colorado and Salt Lake City, Utah. Most goods shipped to the tract come via Interstate 70 to the south, or US Highway 40 to the north. Figure 5-1-1 shows the tract relative to the towns of Rifle, Meeker and Rangely, in Colorado. Access to the tract from Rifle (on I-70) is 18 miles north to the town of Rio Blanco, then 27 miles northwest from Rio Blanco on the Piceance Creek road, and 13 miles west on County Road 24 (which is presently graveled but unpaved). Goods shipped by truck from Salt Lake City or points west can reach the tract via Vernal and Rangely to State Highway 64, then via the Piceance Creek road. Most of the Tract C-a construction and operating personnel live in either Rifle, Meeker or Rangely. The one-way commuting distances to the tract from these towns are as follows: Rifle - 58 miles; Meeker - 51 miles; Rangely - 68 miles.

A 1½ mile access road was constructed from the visitors center at the tract entrance (located on the northeast corner of the tract) in a southwesterly direction to the mine site. The road was constructed 32 ft. wide and surfaced with gravel hauled from the White River. A guardrail has been placed on sections of the access road, as shown in Figure 5-1-2 for vehicle protection. The original Airplane Ridge Road on tract could not be used because its grade was too steep and some turns were too sharp,.

On tract, existing trails are used, wherever feasible, for access to locations away from the main construction areas. The use of off-road vehicles is being limited in order to protect the environment. All contractors have been instructed to use established roads and trails and warned against the use of off-road vehicles without permission from the project manager. When testing existing coreholes for water reinjection purposes, the temporary 6-inch diameter pipeline was installed by hand without the use of vehicles to prevent damage to the vegetation.

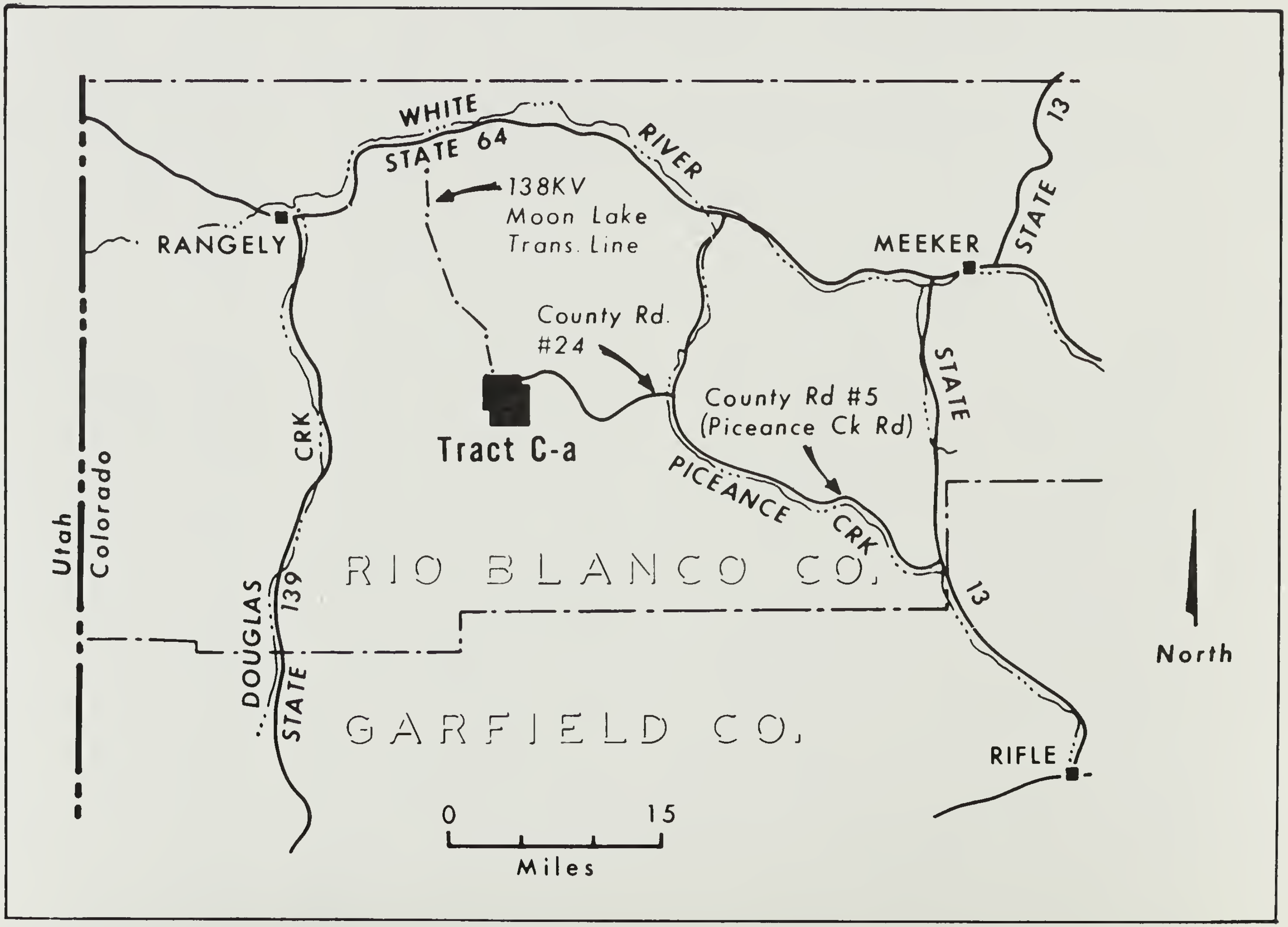


FIGURE 5-1-1
LOCATION MAP OF TRACT C-a

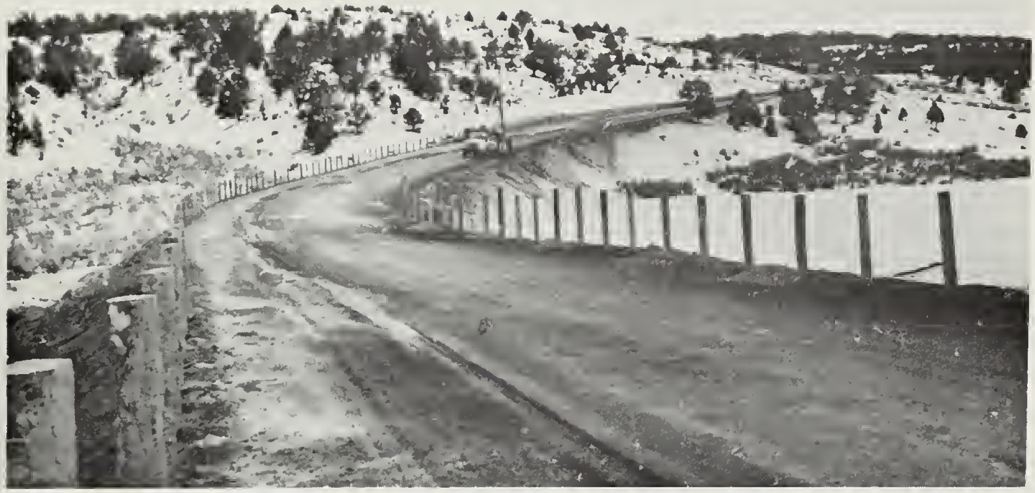


FIGURE 5-1-2
ACCESS ROAD GUARD RAILS

Access to the construction site on tract was originally regulated by having visitors check in at the visitors center. In December 1978, a permanent security guard station was relocated to an area just outside the construction area at a gate location where the security fence crosses the access road. In order to provide protection to the public, livestock and wildlife from hazards associated with construction, RBOSC started fencing the construction area with three strands of barbed wire in October 1978. Completion of this task enclosing about 152 acres out of the more than 5000 acres on tract will be complete in early 1979. The fence, totaling almost 11,000 feet in length, is being built to BLM fence specifications. RBOSC also owns the surface rights to 694 on-tract acres. This includes 534 acres acquired from the Division of Wildlife in 1978. Outside of the fenced area, the public has free and unrestricted access to the remainder of Tract C-a. This use is primarily by hunters during elk and deer season and by companies exploring for natural gas in the vicinity of the tract.

CHAPTER 2
POWER SUPPLY AND DISTRIBUTION

Prior to obtaining permanent power and installing an electrical distribution system, RBOSC used diesel-engine-powered electrical generators for its power needs. The following is a list of the generators being used on Tract C-a until the permanent public utility electric power system is fully energized:

Capacity (KW)	Location
500	Mine Raise Bore Machine
500	Mine Raise Bore Machine Standby
500	Standby
500	Standby
175	Hunt Club Office
65	Administration Building
45	Quality Control Trailer
30	Water Treatment Plant
30	Microwave Phone System
12	Standby
500	Shaft Hoist
500	Shaft Fan and Pumps

Figure 5-2-1 shows some of these temporary generators.

In addition, a 2500-KW standby generator for the permanent power system is on Tract C-a and is presently being outfitted; this is housed in the Generator Building. Figure 5-2-2 shows the standby generator.

Moon Lake Electric Association, Inc. contracted on RBOSC's behalf for the construction of approximately 22 miles of 138-KV transmission line to bring power from their existing facilities to Tract C-a. Work on the first 10 miles of line began in November 1977 from a tap point on Moon Lake's Rangely to Meeker line. Work on the first half of the line

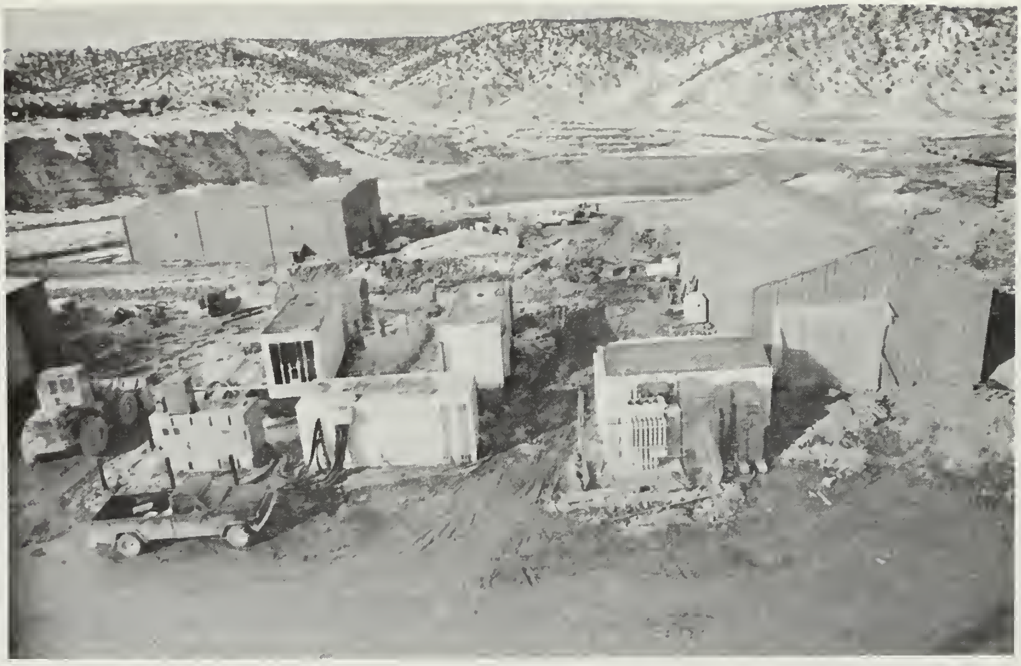


FIGURE 5-2-1

TEMPORARY GENERATORS

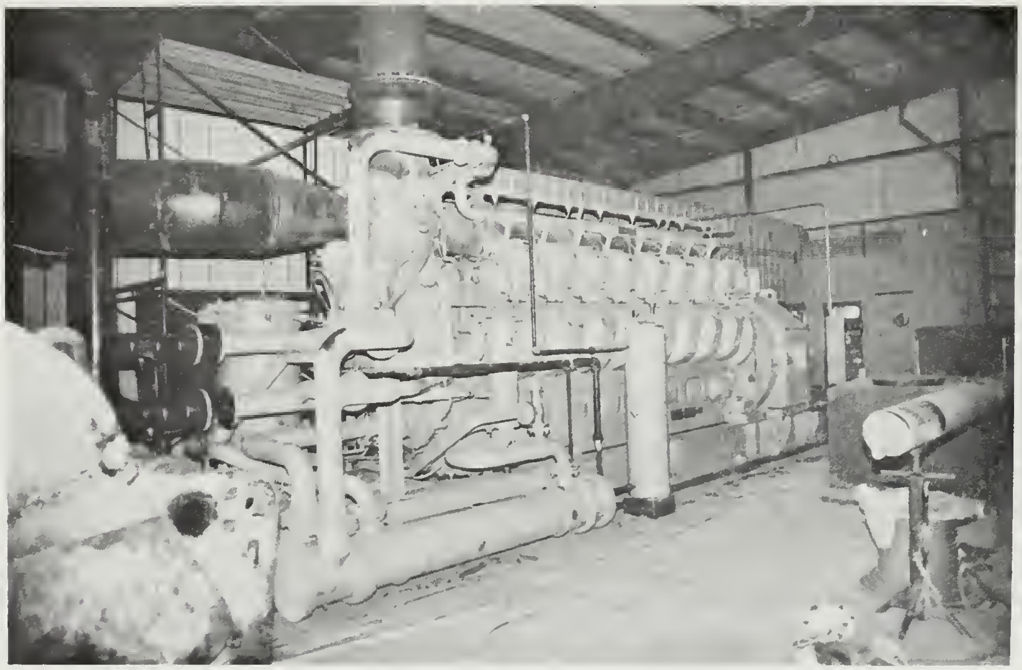


FIGURE 5-2-2

2500 KW STANDBY GENERATOR

continued through the winter of 1977 and was complete by March 1978. To construct the second half of the line during the spring thaw, construction techniques were employed based upon maximum use of helicopters to minimize environmental damage. Figure 5-2-3 shows the helicopter transporting power poles. The second half of the line was completed in approximately 8 weeks. Moon Lake energized the line and started supplying power to the tract about mid-June 1978.

Figure 5-1-1 shows the route of Moon Lake's transmission line to Tract C-a. The 138-KV line constructed from east of Rangely, Colorado, hangs on 2 and 3 wood pole structures 22 miles to the substation on Tract C-a. The main power control center is in the Generator Building on Tract C-a where the standby 2500-KW diesel generator is also housed. In case of a utility system interruption, the standby generator will power necessary equipment such as the mine hoist, mine fan, mine pumps, etc. At the present time a temporary substation and power distribution system is

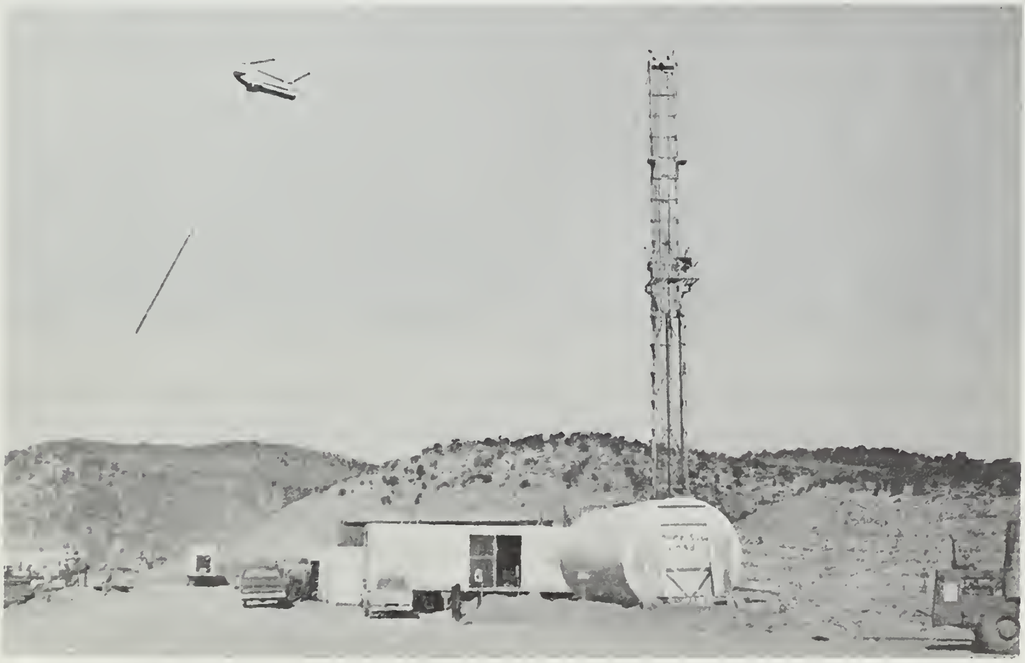


FIGURE 5-2-3

POWER POLES BEING TRANSPORTED BY HELICOPTERS being utilized. A temporary transformer with limited capacity is on loan from Moon Lake. Since June 1978, this has supplied limited power for the dewatering pumps, the mine hoist and fan, and the mine shaft pumps. RBOSC's transformer was set up in May 1978, but will not be energized until the permanent electric distribution system is completed in April 1979. The permanent electrical distribution was started in September 1978. Figure 5-2-4 shows the installation of the underground electrical distribution.

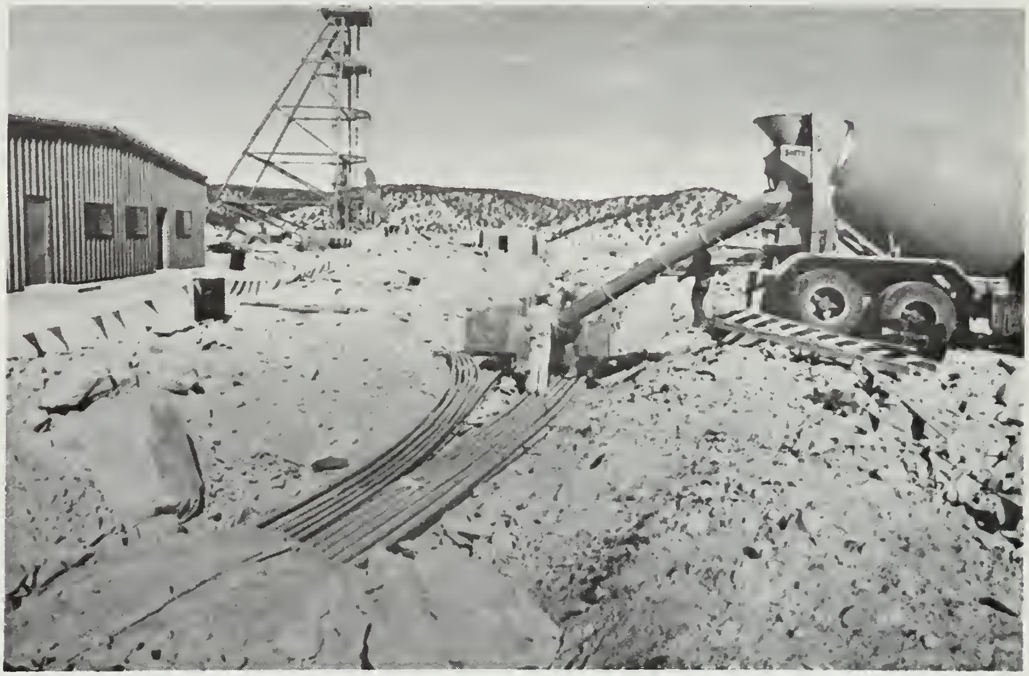


FIGURE 5-2-4
INSTALLATION OF UNDERGROUND ELECTRICAL DISTRIBUTION

CHAPTER 3
WATER MANAGEMENT AND QUALITY CONTROL

3.1 GENERAL CONCEPT

Water for the MIS development of Tract C-a will be supplied by a mine dewatering system and mine seepage water. Mine dewatering is expected to provide more than enough water for the projected demand.

Some of the groundwater will be treated to provide potable water required at the mine facility, process plant, administration building and other areas. Potable water is being imported to the tract while water processing and treatment facilities are being constructed. Other water will be reserved for fire protection. MIS retort water and scrubber blowdown water will be evaporated in lined ponds during the MDP. Processing blowdown water will be used for dust control purposes. The excess groundwater from the mine and dewatering wells may be reinjected back into the groundwater aquifer or discharged to surface drainage.

The water control system has been designed to control surface runoff water, mine dewatering and the processing of waste waters. Surface water originating outside the project area is diverted around the mine site, processing facility and disposal areas. Surface water originating within the project area is controlled by a series of collection ditches and retention ponds, and will be recycled to the reinjection water system, solar evaporated or released to surface drainage.

3.2 STATUS

A. MDP Water Management System - Chapter 5 of Section 5 and Chapter 6 of Chapter 6 of the DDP presented RBOSC's concept for water handling during the MDP. Since development began in September 1977, new information on the quantity and quality of the upper aquifer water under Tract C-a has been obtained which necessitated modification of some of our water management plans. Figure 5-3-1 is a flow diagram of the current MDP Water Management System.

During the development of the Herget Shaft, water with higher suspended solids has been encountered in a greater quantity than had been anticipated. In order to reduce the suspended solids prior to reinjection, the present plan is to send all dewatering well water and mine seepage water to the West Retention Pond for gravity settling prior to reinjection. Construction of the 30-acre-ft. West Retention Pond began in June 1978, and was 90% complete when weather halted construction in the fall. This pond was constructed with an impervious clay liner obtained from a borrow area near the Hunt Club office. A baffle system to distribute incoming water evenly over the cross section of the pond allowing settling of suspended solids will be installed this spring. Figure 1-2-5 shows the pond under construction in October 1978.

The West Retention Pond will contain waters from the following sources: dewatering wells; mine seepage; and mine service area runoff. As required by Section 9.C(6) of the Tract C-a prototype oil shale lease, the lessees will not reinject water except in compliance with state and federal standards and where authorized to do so by the mining supervisor.

During the latter part of 1978, mine seepage water was pumped into a settlement pond at the headframe to achieve partial settling of solids. Water from the pond then flowed by gravity to the Mine Seepage Water Treatment system where multi-media filtration took place. It then flowed through a flume where discharge quantity was measured, and over erosion control structures prior to discharge down Corral Gulch. Figure 5-3-2 is a picture of the headframe settling pond; Figure 5-3-3 is a picture of the Seepage Water Treatment Plant; and Figure 5-3-4 is a picture of the flume.

The supply for potable water was originally planned to come directly from upper aquifer dewatering wells. The present plan for a source of

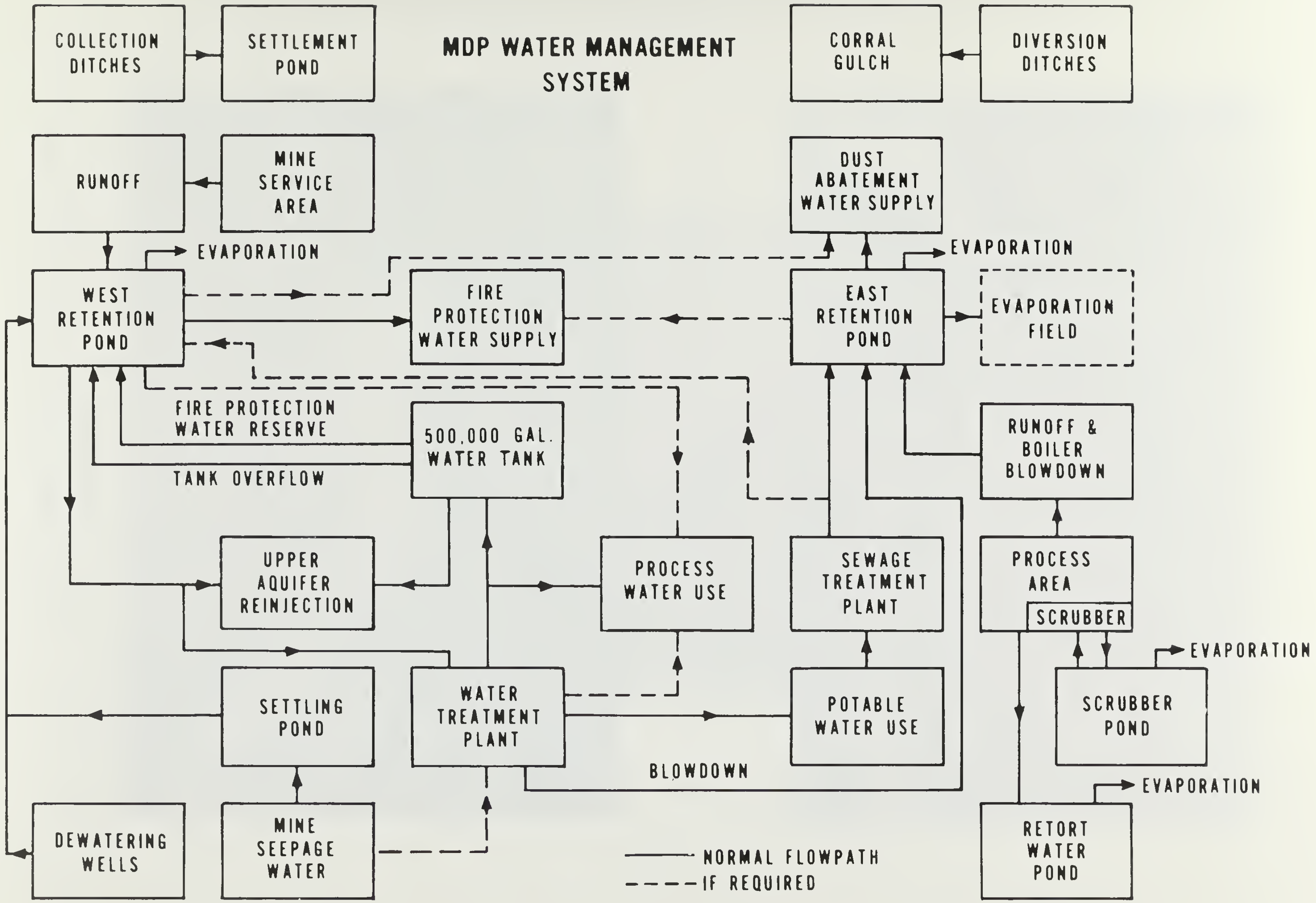


FIGURE 5-3-1

MDP WATER MANAGEMENT SYSTEM

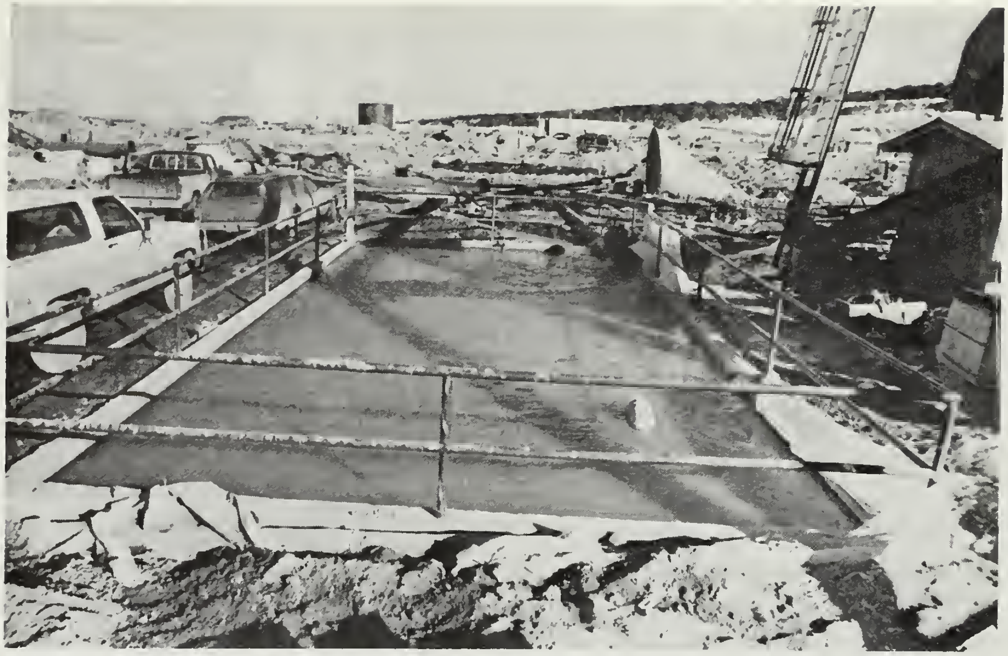


FIGURE 5-3-2

HEADFRAME SETTLING POND

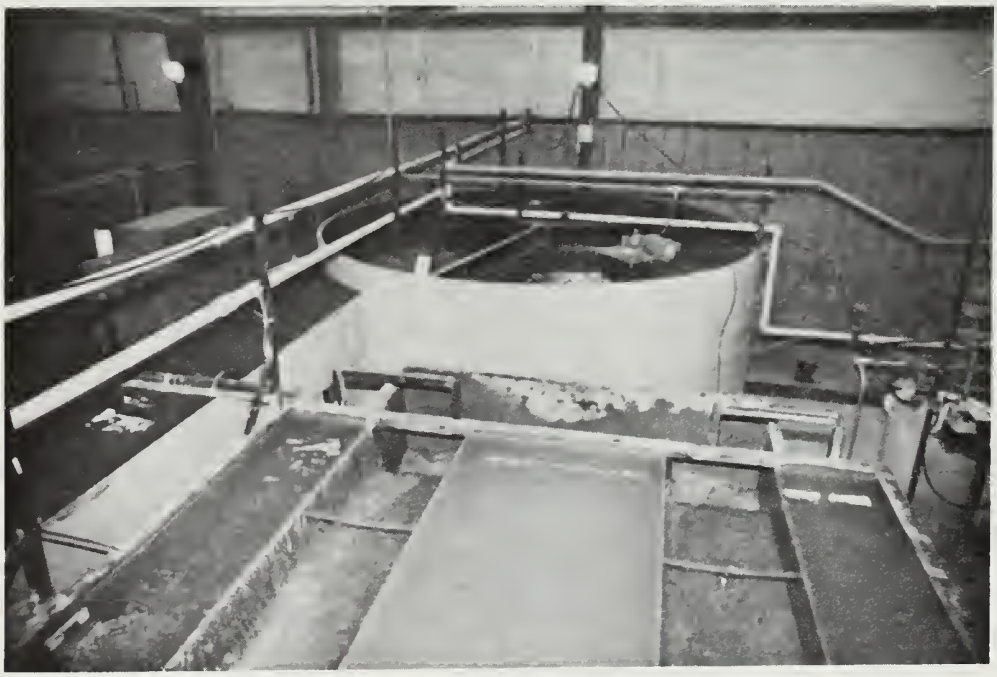


FIGURE 5-3-3

SEEPAGE WATER TREATMENT PLANT

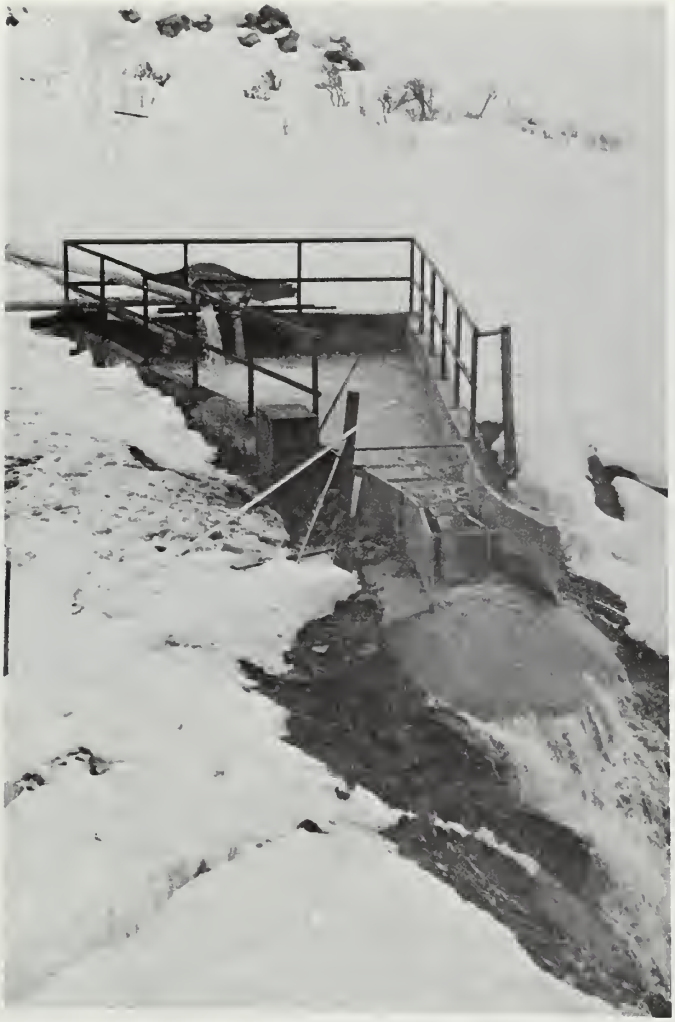


FIGURE 5-3-4
FLUME

potable water is to use water (after settling) from the West Retention Pond. This water will be treated in the potable water treatment system by reverse osmosis and filtration. Construction of this plant was begun in May 1978 and was estimated to be completed in January 1979. The system is completely installed and will be tested in the spring of 1979. Figure 5-3-5 is a picture of the potable water system located in the Water Treatment Plant.

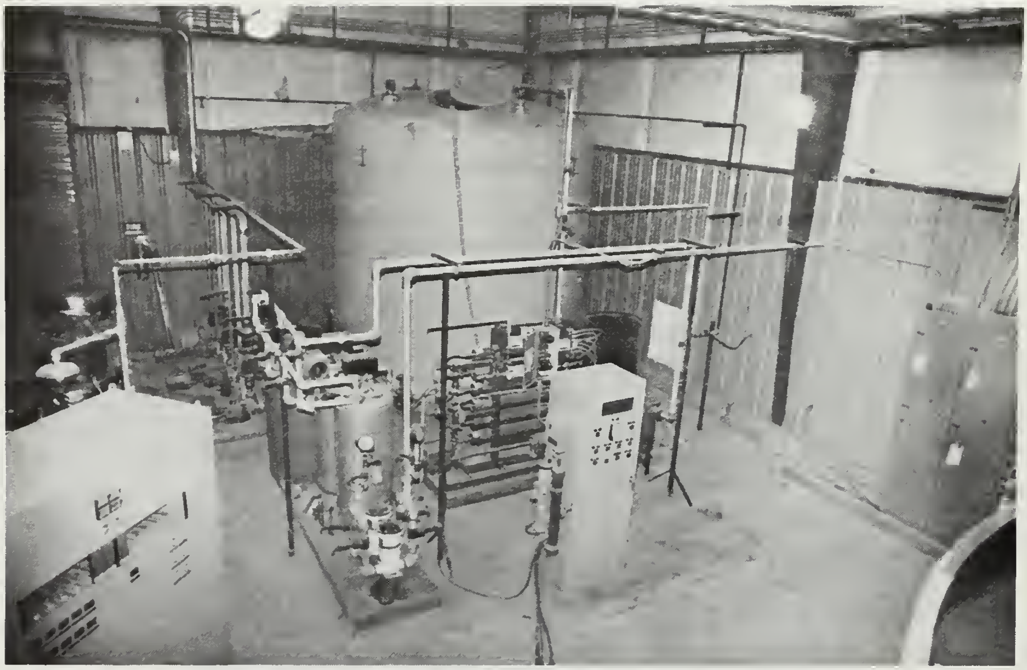


FIGURE 5-3-5
POTABLE WATER PLANT

Construction of the 30-acre-ft. East Retention Pond began in June 1978, and was completed in October 1978. This pond is also constructed with an impervious clay liner and is designed to receive blowdown water from the sewage treatment plant, mine seepage water treatment plant, boiler blowdown, and process area water treatment plant. The process area storm sewer and waste water sewer are also piped to this pond. Aside from evaporation, the principal outflow will be water for dust suppression. Additionally, the East Retention Pond is a secondary fire water supply. The East Retention Pond is shown in Figure 1-2-5.

Construction of a Sewage Treatment System, designed to treat 14,000 gallons per day, was started in December 1978 and was approximately 50% complete by December 31, 1978. The system is generally described as an extended aeration treatment plant. The plant is scheduled to be operational in the spring of 1979. The Sewage Treatment Plant was installed just east of the Water Treatment Plant and is shown in Figure 5-3-6.

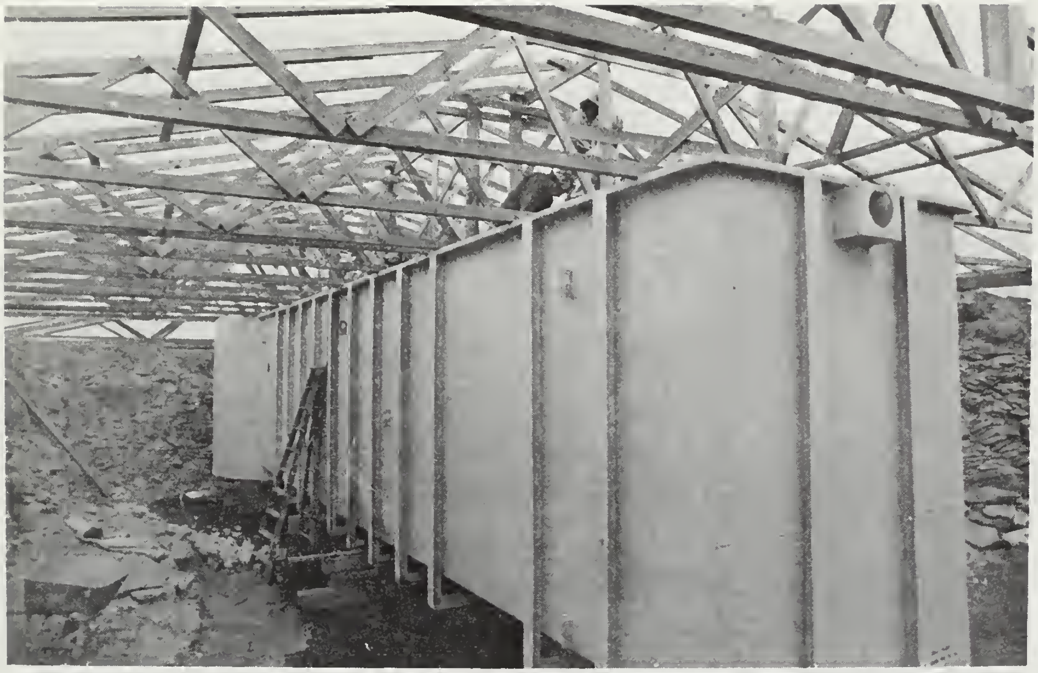


FIGURE 5-3-6
SEWAGE DISPOSAL PLANT WITH TEMPORARY WOOD FRAME AND
PLASTIC COVER (NOTE: PLANT BELOW GROUND LEVEL)

Two separate 100-year precipitation event water handling systems were installed around the Tract C-a construction site in September 1978. On the uphill side of the construction site, diversion ditches were built to divert storm water around the cleared areas to and prevent erosion and siltation of stream water. Erosion control devices will be built within the diversion ditches in the steeper ditch runs as required. The diverted storm water enters the natural drainage courses and eventually reaches Corral Gulch. The runoff ditches were built downhill or below the construction site. Any precipitation on the mine bench side slopes will be channeled by the runoff ditches to the West Settling Basin. Any runoff from the area below the guard shack and the ROM disposal area will go to the East Settling Basin. Precipitation which falls on the mine and plant bench will be piped through the storm sewer system to the West or East Retention Pond or both ponds.

As explained in Section 3, RBOSC has modified its plans for scrubbing the MDP flue gases and handling the water produced from retorting. Ponds will be built to evaporate the scrubber blowdown and retort water. These ponds will be built in stages since the amount of water produced for evaporation can only be estimated at this time. The ponds were approved to be lined with plastic and a leak monitoring system will be incorporated.

The fire water system is explained in Section 6, Chapter 3, Fire Protection and Control.

B. Dewatering and Reinjection - The DDP postulated several pairs of wells in the vicinity of the mine shafts and mine service area. One of each pair would pump from the upper aquifer and the other from the lower aquifer. It was decided early in the program to avoid penetrating the lower aquifer with any of the openings of the MDP and therefore no dewatering wells have been drilled into the lower aquifer.

Five dewatering wells have been drilled through the upper aquifer in the MDP mine area in late 1977 and early 1978. Four of these, designated D-1 through D-4, are located near the Herget Shaft and the fifth, D-5, is east of the mine area as shown in Figure 5-3-7.

The dewatering wells were all initially equipped with large capacity submersible pumps. As pumping rates declined, smaller pumps were installed in all of the wells. Considerable early mechanical and electrical difficulties were experienced with these pumps but more recently, the submersible pumps in the dewatering wells have performed with fewer problems.

Figure 5-3-8, which illustrates both cumulative volume of water pumped and cumulative volume reinjected, shows that just in excess of 3000 acre ft. had been pumped of which about one-third had been reinjected by the end of 1978.

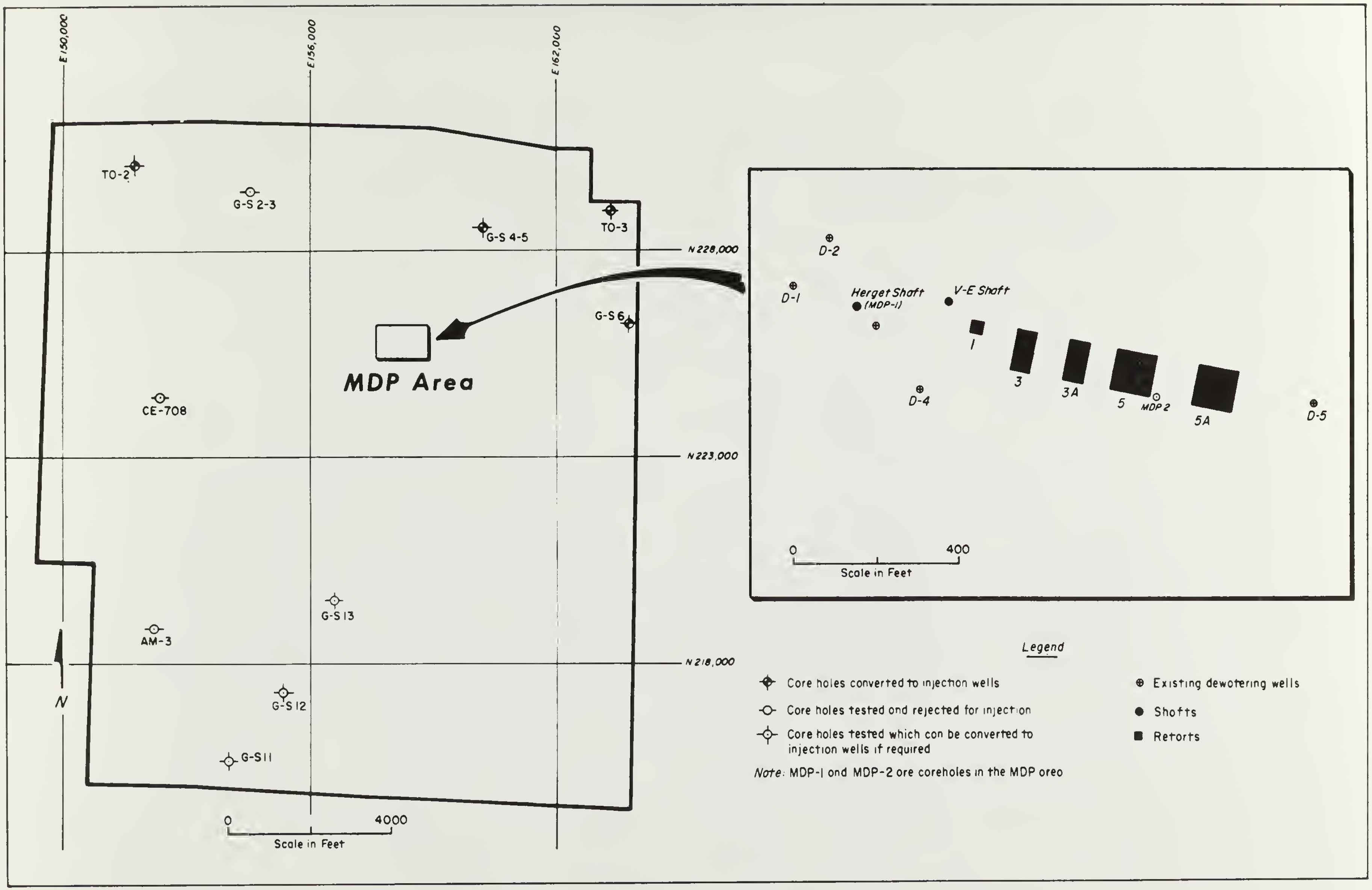

E150,000
E156,000
E162,000
N228,000
N223,000
N218,000
TO-2
G-S 2-3
G-S 4-5
TO-3
G-S 6
CE-708
MDP Area
G-S 13
AM-3
G-S 12
G-S 11
N
0
4000
Scale in Feet
D-2
D-1
Herget Shaft (MDP-1)
V-E Shaft
1
3
3A
5
MDP 2
5A
D-4
D-5
0
400
Scale in Feet
Legend
Core holes converted to injection wells
Core holes tested and rejected for injection
Core holes tested which can be converted to injection wells if required
Existing dewatering wells
Shafts
Retorts
Note: MDP-1 and MDP-2 are coreholes in the MDP area

FIGURE 5-3-7

TRACT C-a DEWATERING/REINJECTION PROGRAM

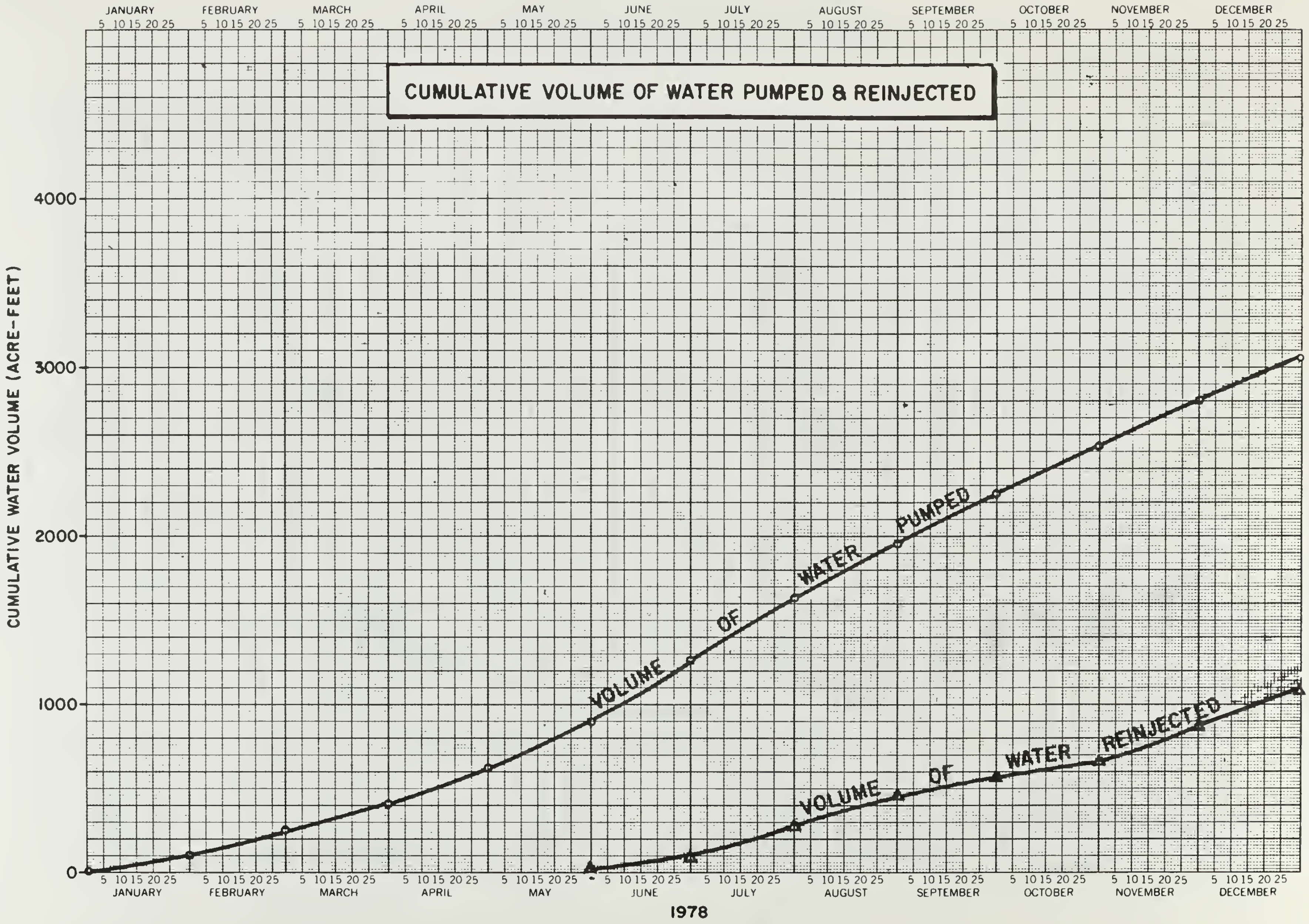


FIGURE 5-3-8

CUMULATIVE VOLUME OF WATER PUMPED AND REINJECTED

The DDP stated that "The area to be covered by the underground operations will be initially dewatered by surface pump wells before mining begins. However, considerable residual water is expected in certain parts of the oil shale interval. Therefore, the levels have been designed to accept substantial water inflows." Most of the 800 to 900 GPM now flowing into the mine is coming from E level which is near the bottom of the upper aquifer. C level and the bottom of the shaft, (at 702 ft. in early 1979) were both relatively dry.

Figure 5-3-7 shows the locations of proposed injection wells, current injection wells and holes tested for injection and found to be unsuitable. By the end of 1978, four injection wells, G-S 4-5, G-S 6, TO 2 and TO 3 were accepting a total of 1200 GPM, or just over half of the water produced. This was the entire production from the five dewatering wells. All reinjection wells are located on tract. The remainder of the water, which is the mine seepage water, is being discharged to Corral Gulch through a Parshall Flume (Figure 5-3-4).

Until now it has not been possible to assess what part of the reinjected water, if any, is returning to the mine. A complete suspension of reinjection is planned in early 1979 to test the effect on inflow to the mine. After a period of several weeks of complete suspension, individual injection wells will be brought back on stream, one at a time, and again the effect on shaft inflow noted. This test should yield a good estimate of the effect of injection on inflow to the mine.

Figures 5-3-9 and 5-3-10 are pictures of typical dewatering and reinjection wells. During October and November 1978, insulated sheds were put over these wells to protect them from freezing. These buildings can be heated if necessary. One of these buildings is shown in Figure 5-6-11.

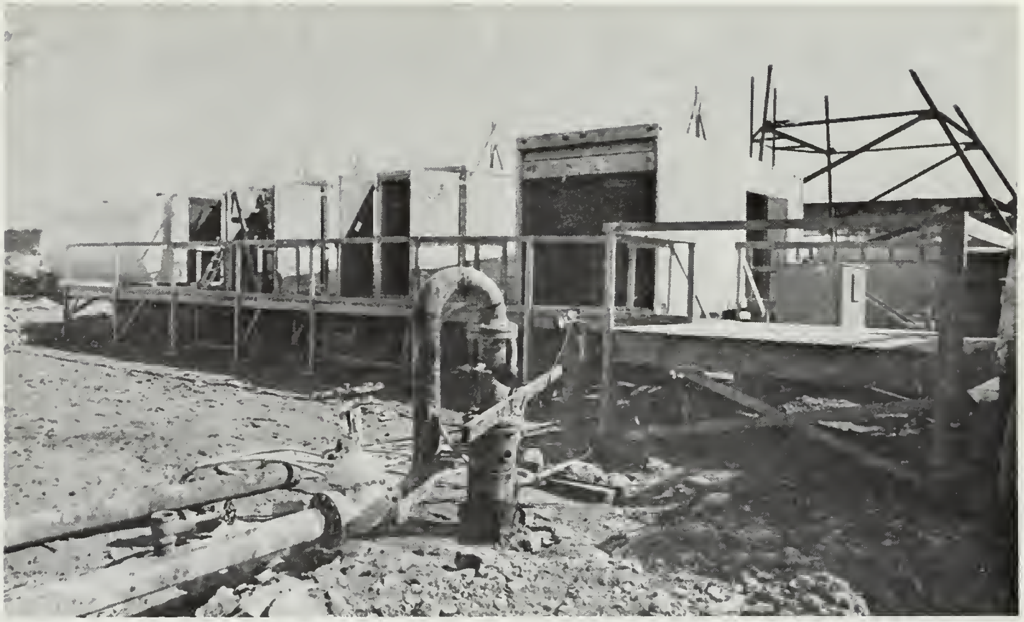


FIGURE 5-3-9
DEWATERING WELL

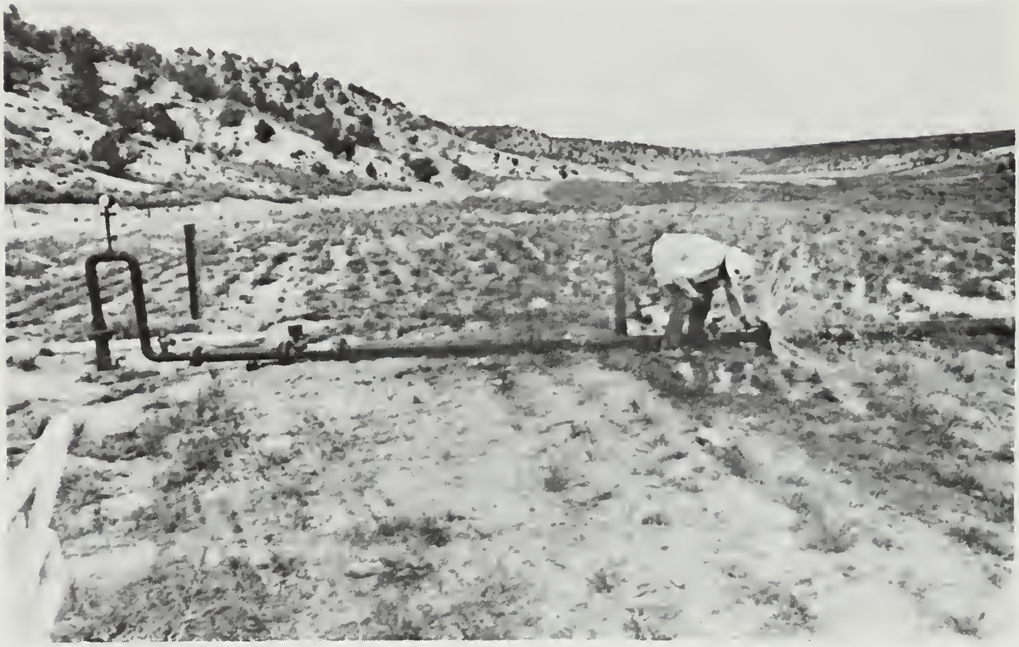


FIGURE 5-3-10
REINJECTION WELL

CHAPTER 4
COMMUNICATIONS

Beginning in late 1974, a radio telephone provided communication service to Tract C-a via an answering service which interfaced with Mountain Bell Telephone Company in Grand Junction. This was used until December 1977. During 1978, a microwave telephone system from Grand Junction provided an intra-project, local and long distance telephone service to Tract C-a. With the completion of the Administration Building on site in December 1978, RBOSC installed an electronic PBX telephone system with increased capability for handling external trunks and intra-project lines. Presently, this capability is limited to 6 external trunks by the microwave system.

At this time RBOSC is looking into the possibility of expanding the microwave system to provide additional external trunk lines to facilitate computer ties with off-site computer facilities and to utilize foreign exchange and tie lines.

Communications on Tract C-a are accomplished with FM 2-way radios mounted in vehicles and with hand-held walkie-talkie type units. Two base stations are utilized; one at the Administration Building and the other at the Hunt Club office. In general, the system works well except for some interference from another nearby construction project.

At this time, underground communication between C station and E station and the toplander and hoistman is possible through three systems. Pager-type mine phones and two signal-bell systems are presently being utilized. This was described in more detail in Section 2, Chapter 2.

CHAPTER 5

STORAGE AND DISTRIBUTION OF FUEL AND OTHER SERVICE PRODUCTS

Both gasoline and diesel fuel were stored in leased or owned tanks located inside diked areas at the construction site. The largest tank on tract had a storage capacity of 32,000 gallons and was used to store diesel fuel. An estimate of the diesel and gasoline usage by quarter is given as follows:

Quarter	Gasoline (gallons)	Diesel (Gallons)
4th - 1977	17,119	126,458
1st - 1978	15,355	55,936
2nd - 1978	33,932	152,863
3rd - 1978	28,339	62,700
4th - 1978	28,433	19,005

Installation of a permanent fuel storage and dispensing facility located near the Generator Building was started in late 1978. One 20,000-gallon tank with submersible pump will supply a day tank in the Generator Building and mobile equipment with diesel fuel as required.

Two 10,000-gallon tanks with submersible pumps and dispensers will be installed at the plant fueling island. One tank will be used for leaded gasoline and the other for unleaded gasoline. Another 10,000 gallon fuel oil tank will be used to supply mobile equipment in the mine with diesel fuel by gravity, flowing by demand to one of three underground equipment fueling stations.

Figure 5-5-1 is a picture of a fuel storage tank in the fuel storage area.

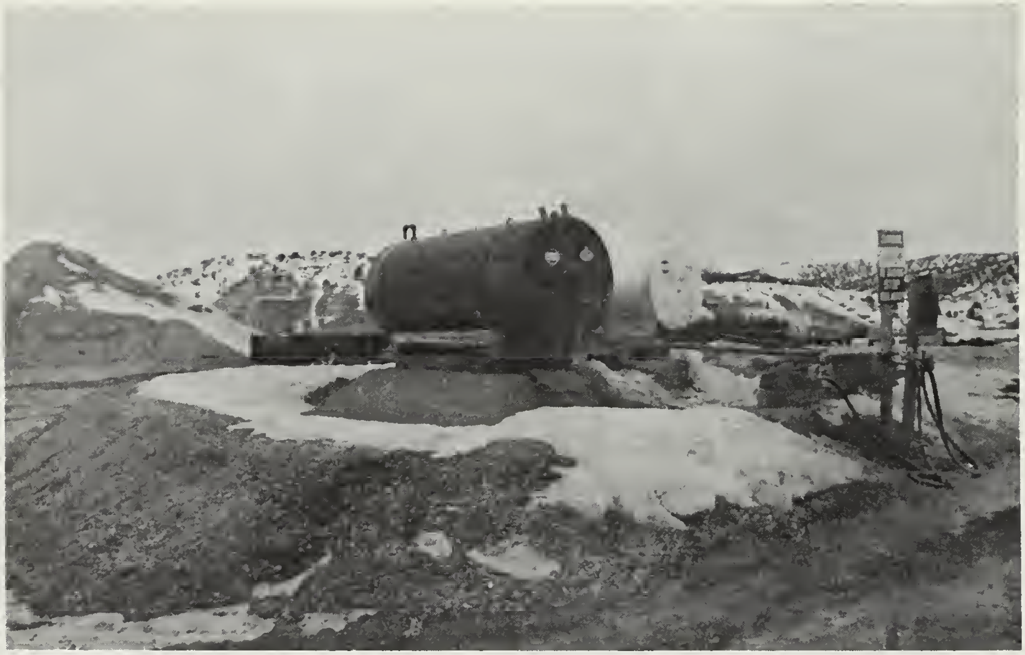


FIGURE 5-5-1

FUEL STORAGE TANK

CHAPTER 6
BUILDINGS

The following buildings were constructed or under construction on Tract C-a during 1978. Their status is shown below:

	Start	Completion	In Use
Administration Building	July	December	Yes
Warehouse Building	July	December	Yes
Water Treatment Plant Building	Nov.'77	June	---
Shaft Water Treatment System	May	May	Yes
Potable Water System	May	Jan.'79 est.	No
Sewage Treatment System	Dec.	April '79 est.	No
Mine Rescue Building	Oct.	April '79 est.	No
Generator Building (Standby)	May	August '79 est.	No
Fire Pump House	June	December	No
Hoist House	Jan.	April	Yes
Mine Mechanics Shop	Jan.	March	Yes
Mine Compressor Building	Sept.	Jan. '79 est.	No
Hunt Club Office	April	July	Yes
Security Officers Building	Dec.	Jan.'79 est.	yes
Core Storage Building	June	July	Yes
Dewatering/Reinjection Well Buildings (9)	October	November	Yes

All facilities, such as the miners' change house and offices were initially established in trailers. At one time, 10 office trailers were in use. At the end of 1978, only 4 office trailers were being utilized. Six tractor trailer vans for warehousing were also in use. The office trailers are being used as the shaft inspectors and quality control office, offices for the shaft contractor and process facility foundation contractor, and a first aid station. All of these office trailers and vans are located on the construction site except the first aid trailer located at the Visitor's Center near the tract entrance.

Figures 5-6-1 through 5-6-12 show buildings on-site that are not shown in other sections of this report.

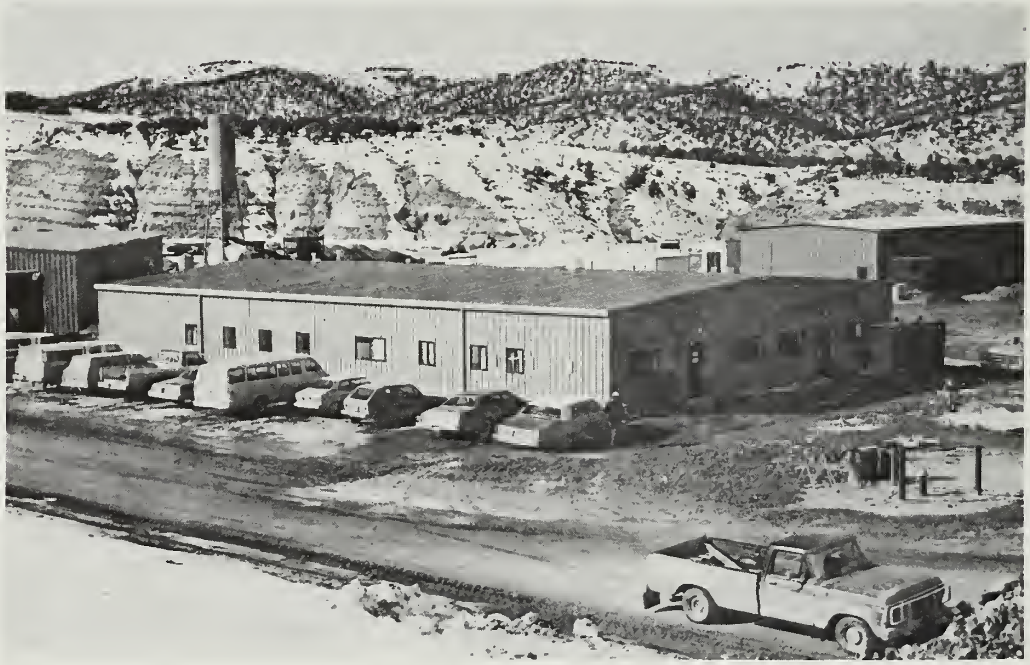


FIGURE 5-6-1
ADMINISTRATION BUILDING

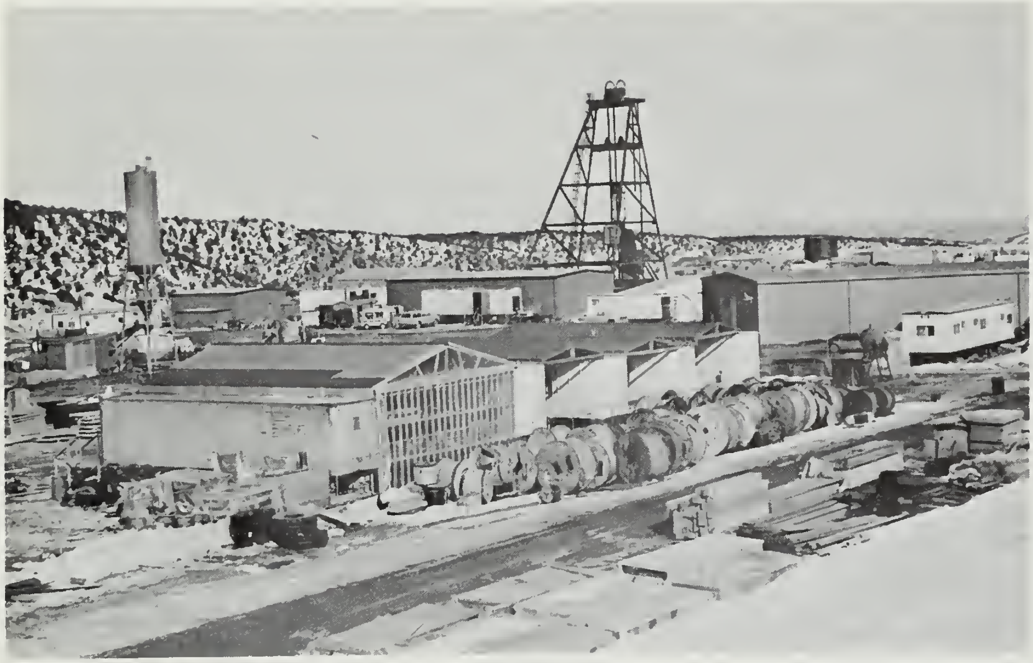


FIGURE 5-6-2
YARD WAREHOUSE

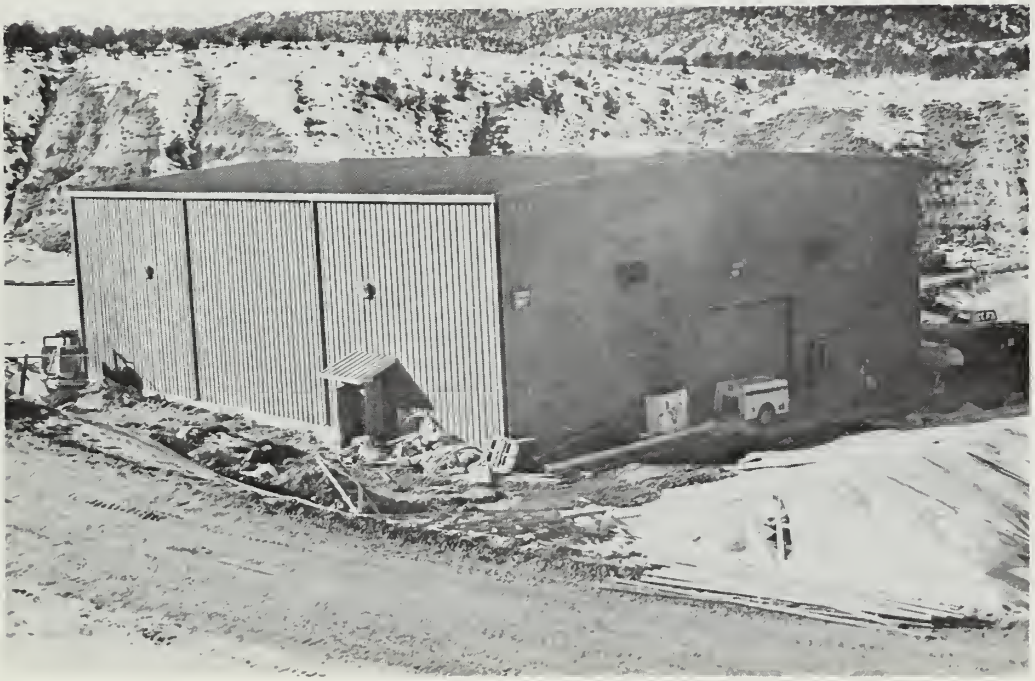


FIGURE 5-6-3
WATER TREATMENT BUILDING

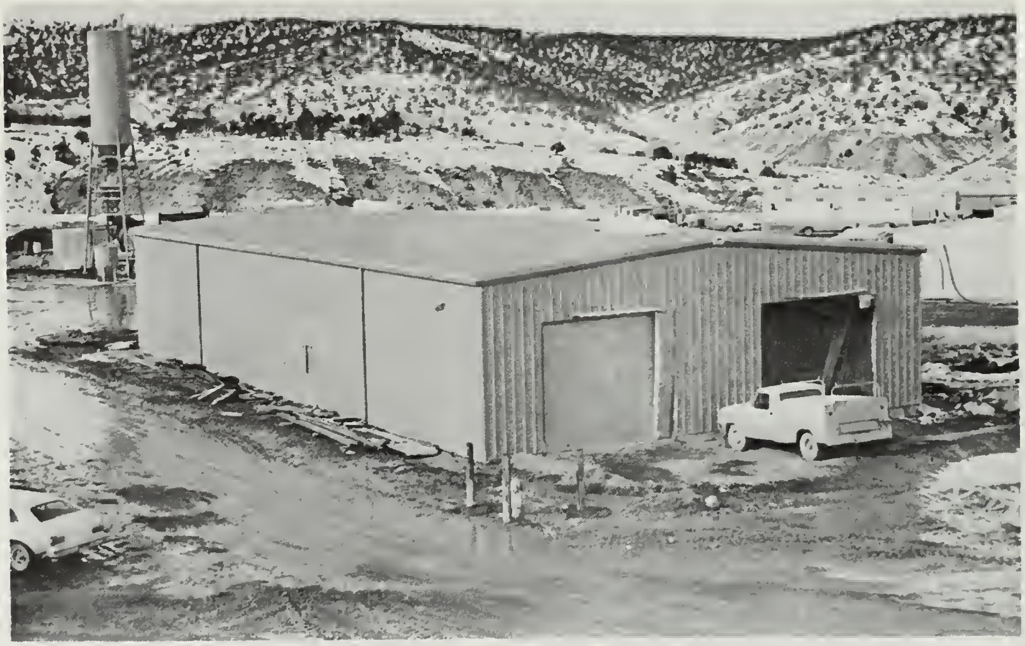


FIGURE 5-6-4

MINE RESCUE BUILDING

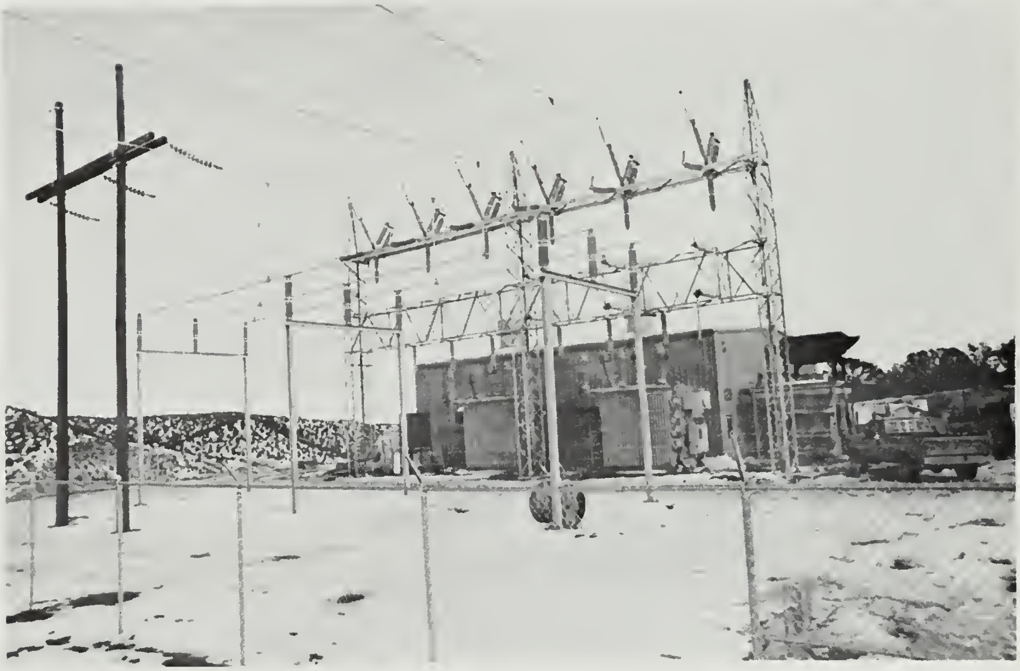


FIGURE 5-6-5

GENERATOR BUILDING

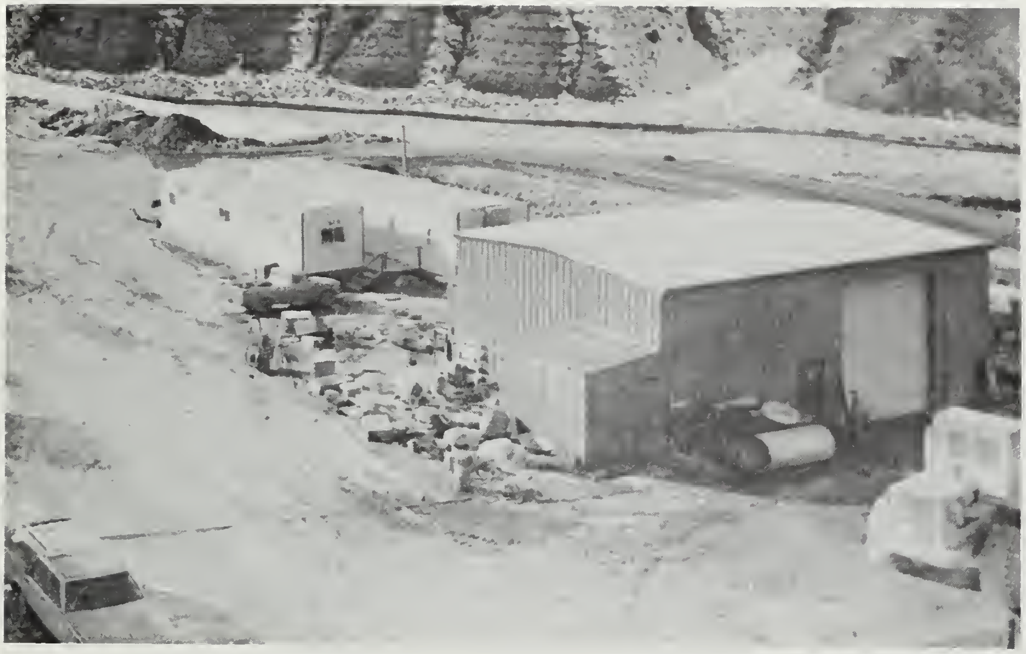


FIGURE 5-6-6

MECHANICS SHOP

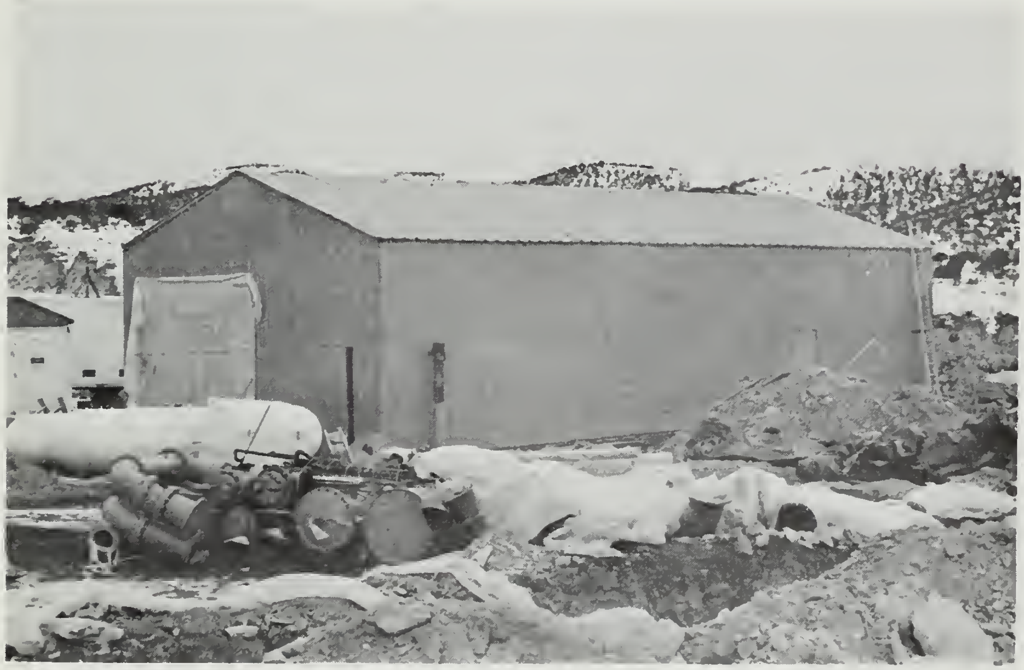


FIGURE 5-6-7

COMPRESSOR BUILDING

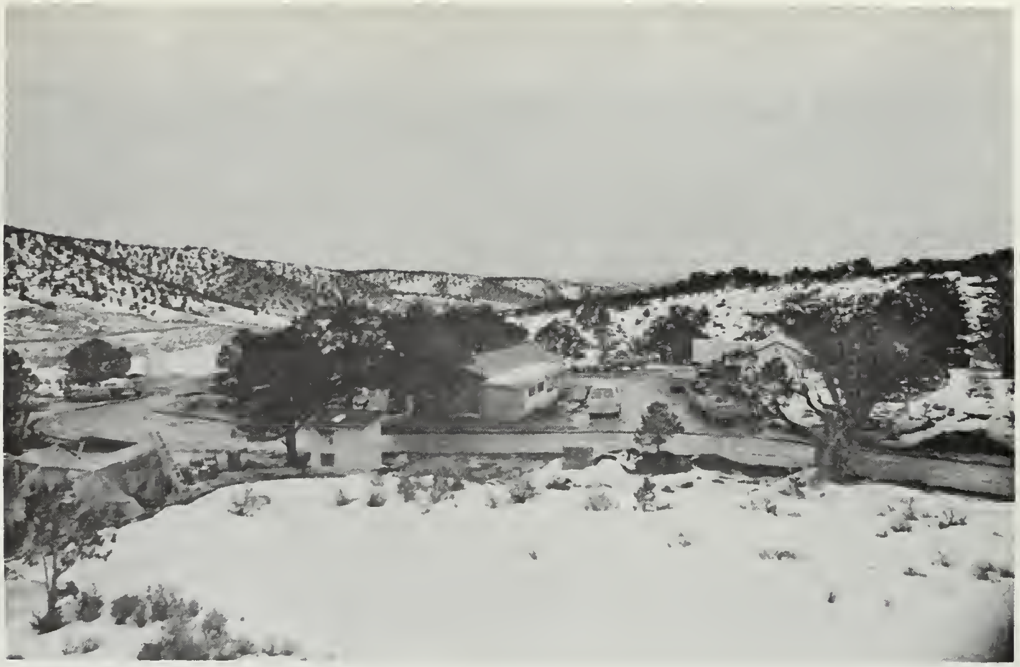


FIGURE 5-6-8
HUNT CLUB OFFICE BUILDING

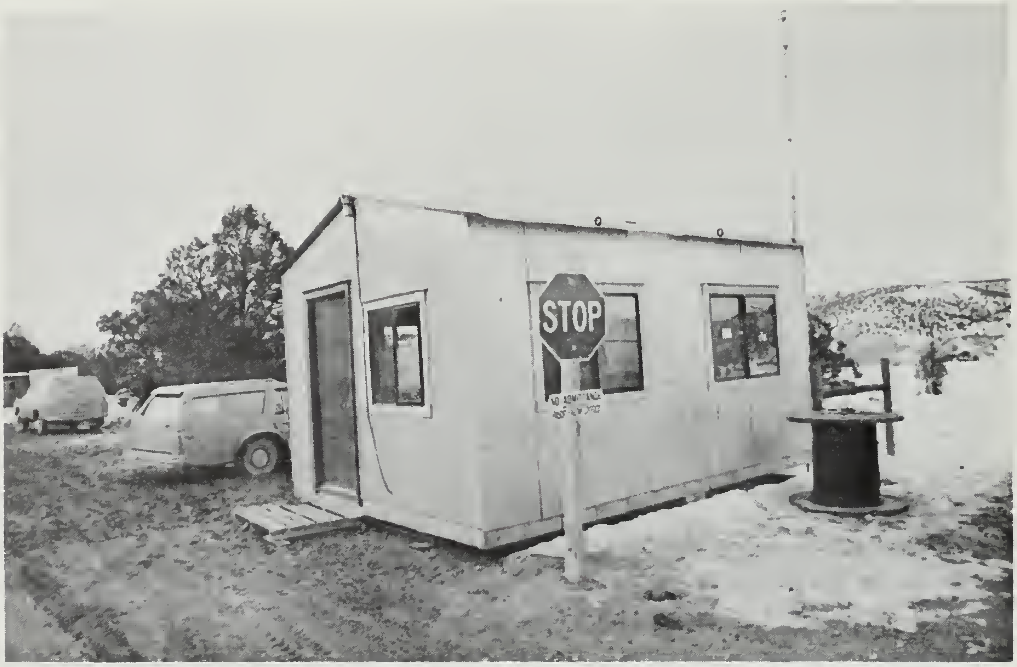


FIGURE 5-6-9
SECURITY BUILDING

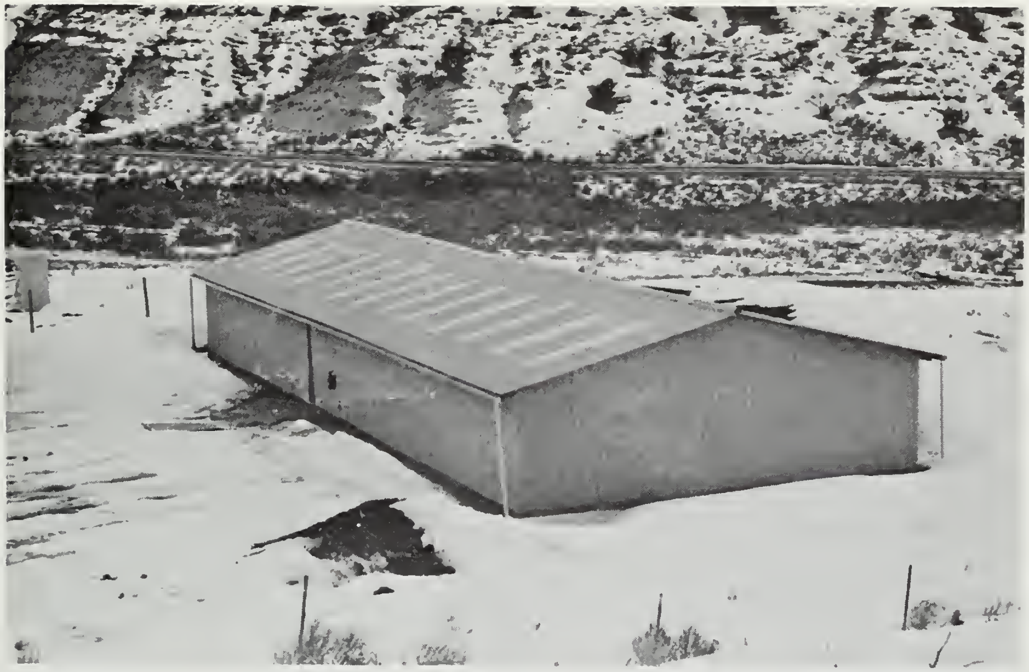


FIGURE 5-6-10
CORE STORAGE BUILDING

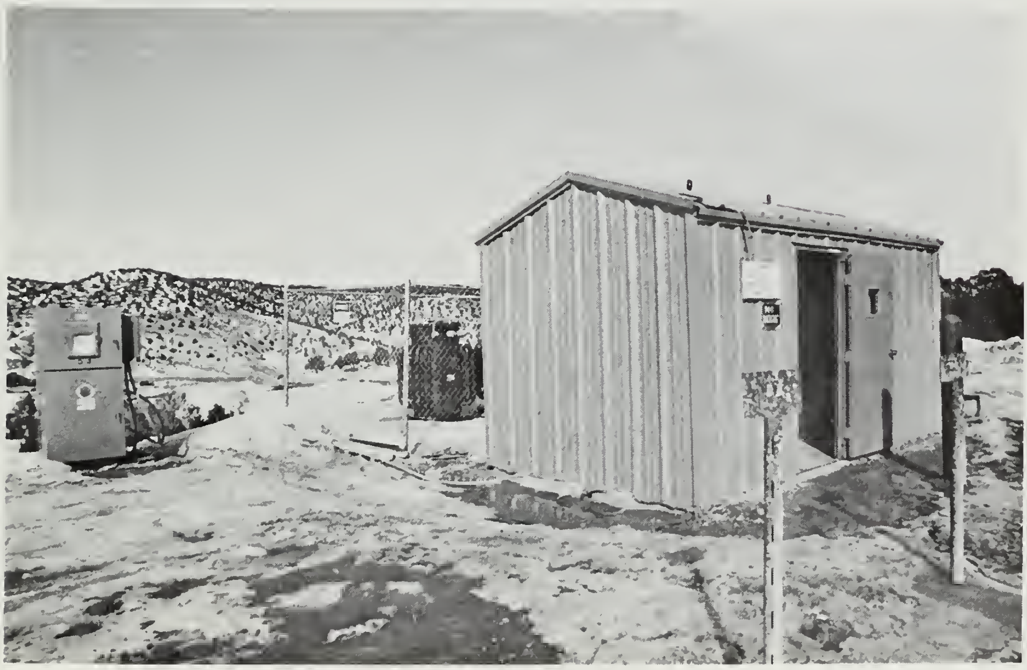


FIGURE 5-6-11
DEWATERING/REINJECTION WELL BUILDING

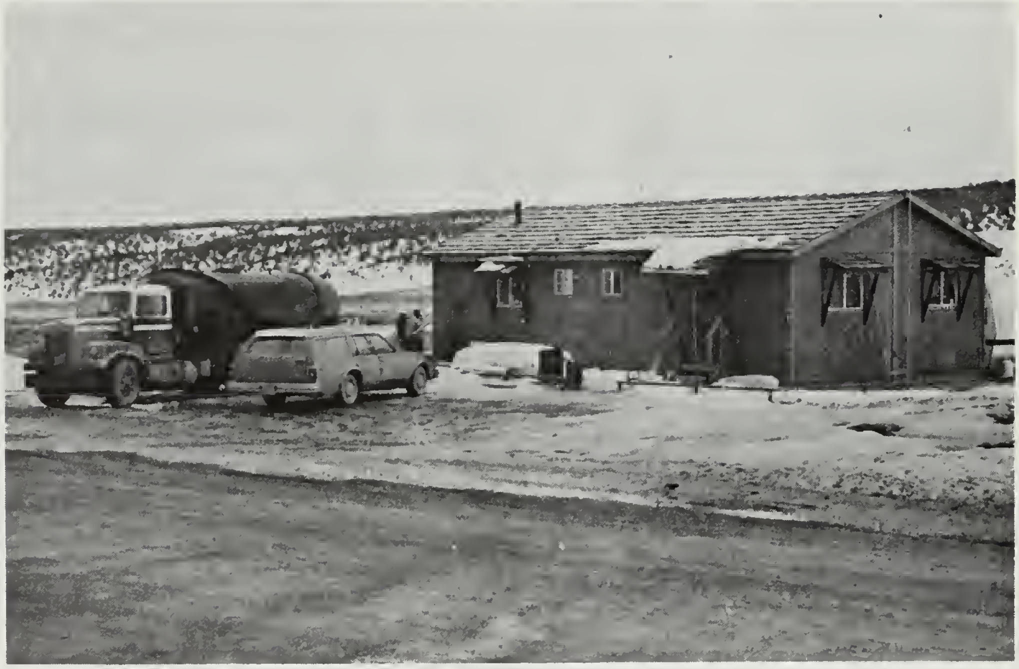


FIGURE 5-6-12
VISITORS' CENTER

CHAPTER 7
EXPLOSIVE STORAGE AND HANDLING

There are two licensed magazines on Tract C-a located as shown on Figure 1-2-3. Blasting caps, both electric and non-electric, are stored in one magazine and high explosives are stored in the other larger magazine. Both magazines were installed in excavated diked pits per Colorado Division of Mines instructions to prevent bullets from penetrating the walls of the magazines. The requirements of the mining subcontractor will determine what additional permanent facilities will be built.

Figure 5-7-1 is a picture of one of the two licensed magazines.

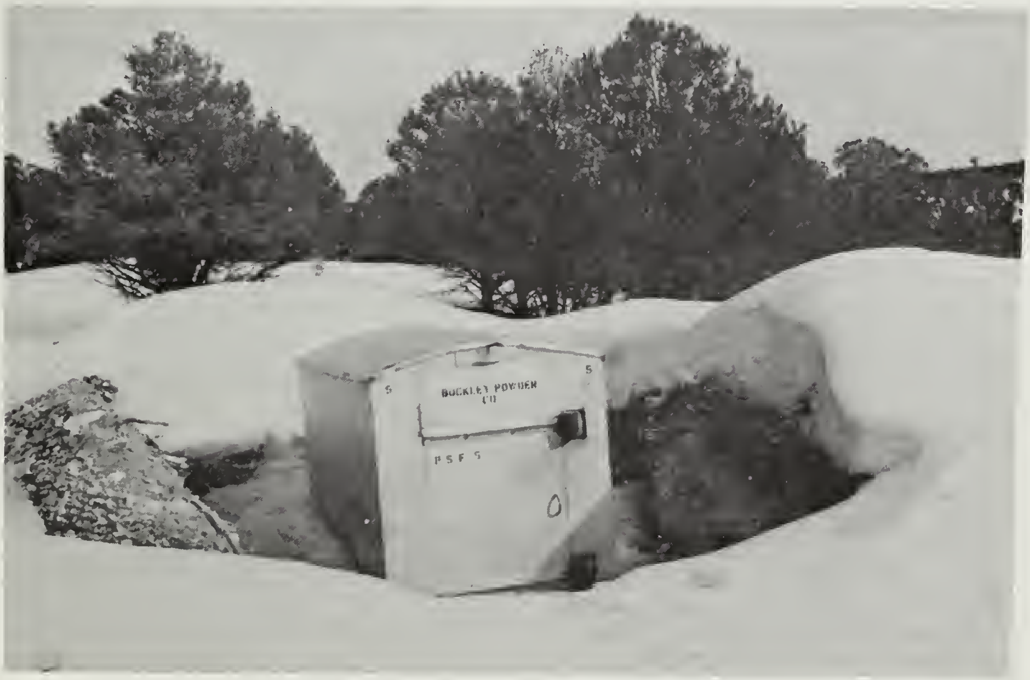


FIGURE 5-7-1
EXPLOSIVES MAGAZINE

SECTION VI

ENVIRONMENTAL PROTECTION, HEALTH & SAFETY

CHAPTER 1

INTRODUCTION

In accordance with applicable federal, state and local statutes, regulations, standards and lease requirements, RBOSC has approached the development of Tract C-a with a sincere desire to make its activities as free from environmental damage as is practicable. Toward this end, environmental interfaces have been included in all engineering work. This has permitted the development of designs and selection of equipment, alternatives and techniques that mitigate or eliminate environmental damage.

The health and safety and environmental protection plans in effect have a threefold function:

- Set forth the pollution control devices and techniques planned for the project.
- Serve as guidelines for detailed design and equipment selection.
- Serve as guidelines for construction and operation of the various facilities in a manner to mitigate environmental damage and comply with permit requirments.

Water quality control was discussed in Section 5, Chapter 3 and will not be repeated here. This section contains discussion on the following: health and safety; fire prevention and control; air quality control; oil and hazardous material control; land rehabilitation and erosion control; solid waste control; fish and wildlife management plan; protection of objects of historic and scientific interest; aesthetics; and subsidence control.

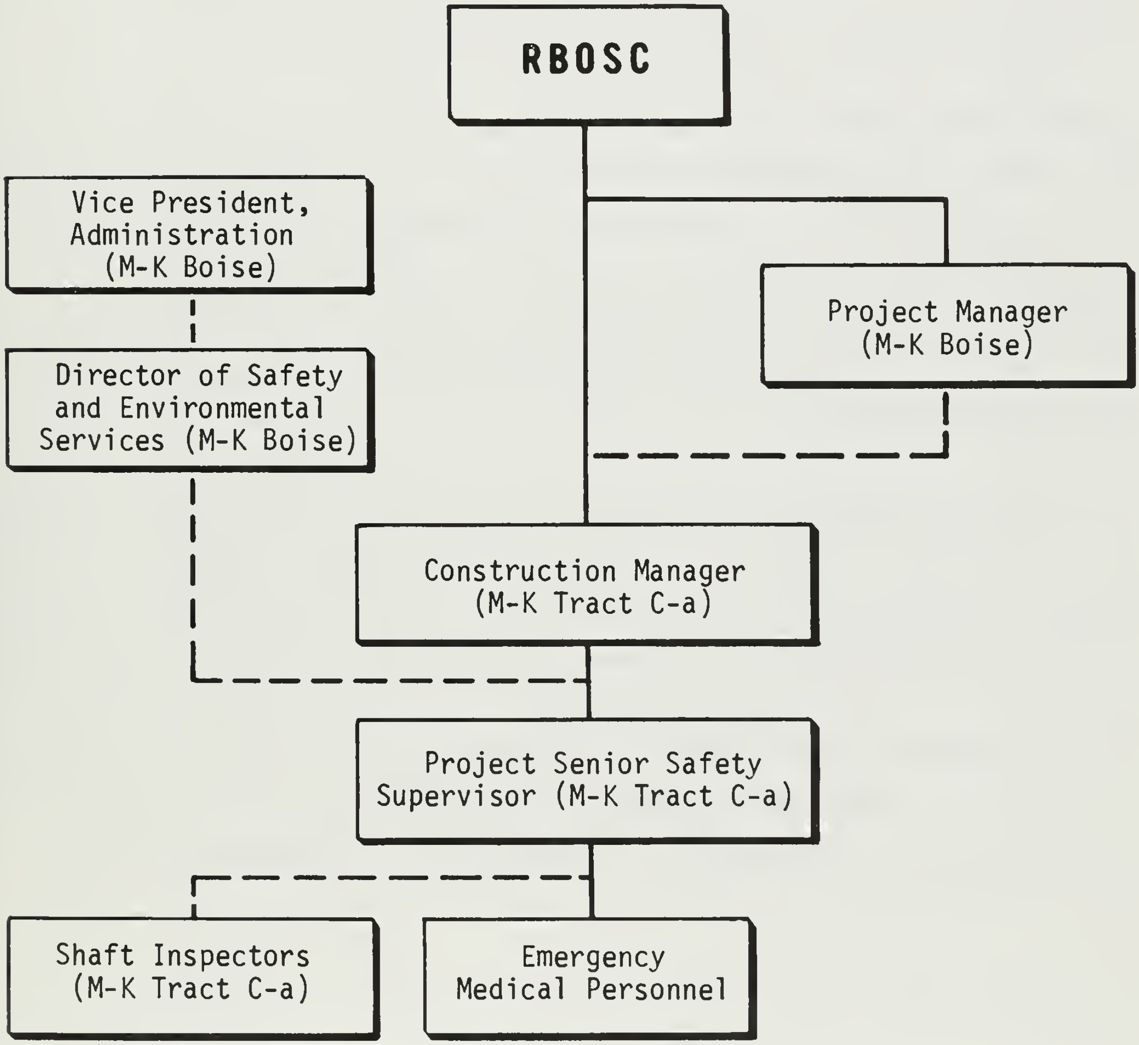
The environmental control plans, equipment and techniques being employed are based on current knowledge and technology in the field. Actual construction and operation is providing additional information on materials, environmental control, and health and safety activities.

RBOSC has taken every opportunity to eliminate, minimize or mitigate any environmental degradation resulting from its operations to date. These programs are being constantly evaluated for effectiveness and will be refined, if necessary, prior to implementation in the Commercial Phase.

CHAPTER 2
HEALTH AND SAFETY

2.1 GENERAL

RBOSC retained the Morrison-Knudsen (M-K) Company of Boise, Idaho as the construction manager and to provide engineering and other technical services during the MDP. As the construction manager for Tract C-a, M-K was responsible to develop, implement and administer a comprehensive Safety and Health Program for the tract. In this capacity, a Safety


RBOSC
Vice President, Administration (M-K Boise)
Director of Safety and Environmental Services (M-K Boise)
Project Manager (M-K Boise)
Construction Manager (M-K Tract C-a)
Project Senior Safety Supervisor (M-K Tract C-a)
Shaft Inspectors (M-K Tract C-a)
Emergency Medical Personnel

Department was established and a Senior Safety Supervisor appointed to head this department. The figure on the prior page shows the organization of the tract Safety Department.

The Senior Safety Director is responsible for: implementing RBOSC's policy of providing a safe and healthy working environment for employees and protecting visitors; ensuring compliance with all applicable regulations on health and safety; providing efficient and immediate emergency medical attention when needed; coordinating and providing ongoing training in health and safety matters; and working with the environmental staff to assure compliance with permit requirements and implementation of appropriate environmental protection and mitigation procedures.

A Safety and Health Program was developed which provided guidelines for all contractors and subcontractors performing work on the project in the field and applied to all personnel on the project site. The program included mandatory policies and procedures for the safe operation of equipment, fire protection, emergencies, training, recordkeeping, environmental protection, material handling and storage, and personal protective equipment.

To achieve the program objectives, it was essential that each contractor and subcontractor implement an effective and vigorous safety and health program to cover his portion of the work. In addition to the provisions of the RBOSC Safety and Health Program, each contractor and subcontractor was directed to take steps to ensure compliance with the applicable regulations and standards of the Colorado safety laws and regulations, the Federal Mine Safety and Health Act of 1977, the game and fish regulations for Colorado and all other applicable federal, state and local regulations.

The Safety and Health Program supplements and enforces the individual programs of each contractor and subcontractor and coordinates the overall safety effort. The responsibility for providing a safe place to work with respect to his portion of the work in turn rests with each individual contractor.

2.2 GENERAL HEALTH AND SAFETY PRACTICES

As part of the Safety and Health Program, the Safety Department performed the following activities during 1978:

- Supervised and coordinated the overall safety and health, security and fire protection programs.
- Conducted and supervised daily inspections of work sites, materials, equipment, and work methods for safe performance and compliance with mandatory safety and health regulations.
- Investigated all serious accidents and ensured adequate records and reports were compiled.
- Reviewed for accuracy and ensured all contractors completed required accident and safety reports and records. Maintained master files of pertinent documents.
- Ensured adequate safety indoctrination and training programs were established and conducted by each contractor. Developed and conducted safety training for M-K and RBOSC employees and other M-K affiliates.
- Provided technical assistance to project management and contractor personnel to resolve any safety problems and to ensure maximum protection for the workers.
- Supervised and cooperated with other safety personnel, industrial hygienists, fire protection and security specialists, and emergency medical personnel as assigned.
- Reviewed losses and claims and implemented effective loss control methods.
- Obtained or supervised the acquisition and maintenance of applicable licenses and permits associated with safety and health protection activities.

- Participated in the acquisition of permits related to environmental protection; assured worker compliance with environmental protection procedures.
- Conducted inspections, monitored and reported on activities of various permits to ensure compliance with and renewal as required by applicable regulations.
- Developed and conducted or supervised the safety indoctrination of all visitors, vendors or other persons visiting or conducting business at Tract C-a.

The M-K quality control shaft inspectors are the front line in respect to control of mine safety. Both M-K and AMS have given direct instruction to the miners in various aspects of safety. As required by federal regulations, all persons going underground are instructed in the use of the self-rescuer. Because of the potential hazard of hydrogen sulfide in the shaft, all of the AMS miners were trained in September 1978 in the use of the Bio-Marine 45 minute breathing apparatus. Five units are stored underground on C level and two spares are on the surface. Six Drager 4-hour breathing apparatus units are also on the property.

Volunteers have been secured to form mine rescue teams made up of tract personnel. These volunteers have received complete, thorough medical examinations to ensure that they are physically able to handle the rigors of training and rescue efforts. Ongoing training will be provided to selected volunteers and will continue throughout the life of the project.

A smoke chamber was constructed on Tract C-a during 1978 and both the mine rescue team and the fire brigade were trained under simulated smoke-filled room conditions. Figure 6-2-1 shows the mine rescue smoke chamber.

Tract C-a employs certified Emergency Medical Technicians (EMT's) on site 24 hours a day, 7 days a week. Continuous training is provided to

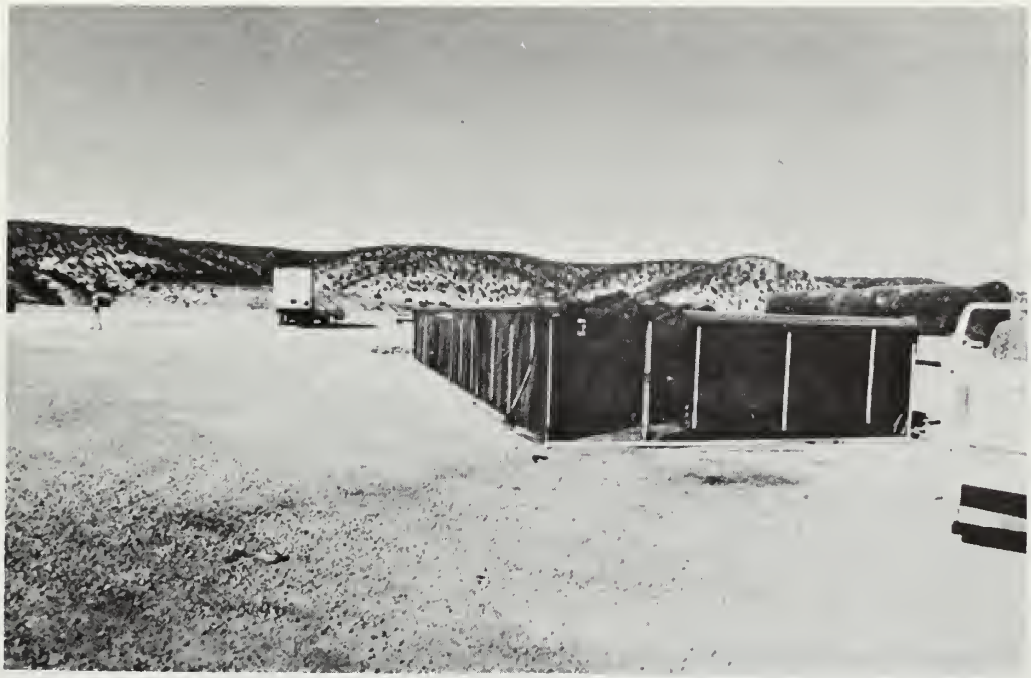


FIGURE 6-2-1
MINE RESCUE SMOKE CHAMBER

the EMT crew to ensure that the best and most up-to-date emergency medical care possible is available to everyone on the tract (or off the tract) if the situation arises. Tract C-a has set up a continuous training program under the auspices of Western Health Education Center in Grand Junction which provides doctors, nurses and paramedics to conduct training sessions. These programs upgrade EMT medical knowledge and keep everyone apprised of modern medical techniques. A mutual cooperative effort between Tracts C-a and C-b is in effect where medical personnel exchange training programs.

An agreement has been made between a physician advisor in Rifle to provide for ongoing training and direct assistance via radio telephone in medical emergencies. Arrangements have been made for transporting injured persons to the hospital in Rifle with more serious cases going to St. Mary's Hospital in Grand Junction. Transport can be accomplished either by Tract C-a ambulance or by fixed-wing plane or helicopter.

Two fully-equipped ambulances are on Tract C-a. Both meet Colorado state regulations and have been inspected by the Rio Blanco County Health Nurse and licensed under Colorado Act 454 governing ambulance and rescue squads. Figure 6-2-2 shows these ambulances.

Additional safety inspectors, industrial hygienists, fire protection specialists, security guards and medical personnel will be assigned as necessary if additional shifts are added, manpower levels increase and work operations become more critical or hazardous. Also, Gulf and Standard have and will continue to supply technical expertise in the safety and health area, as required.

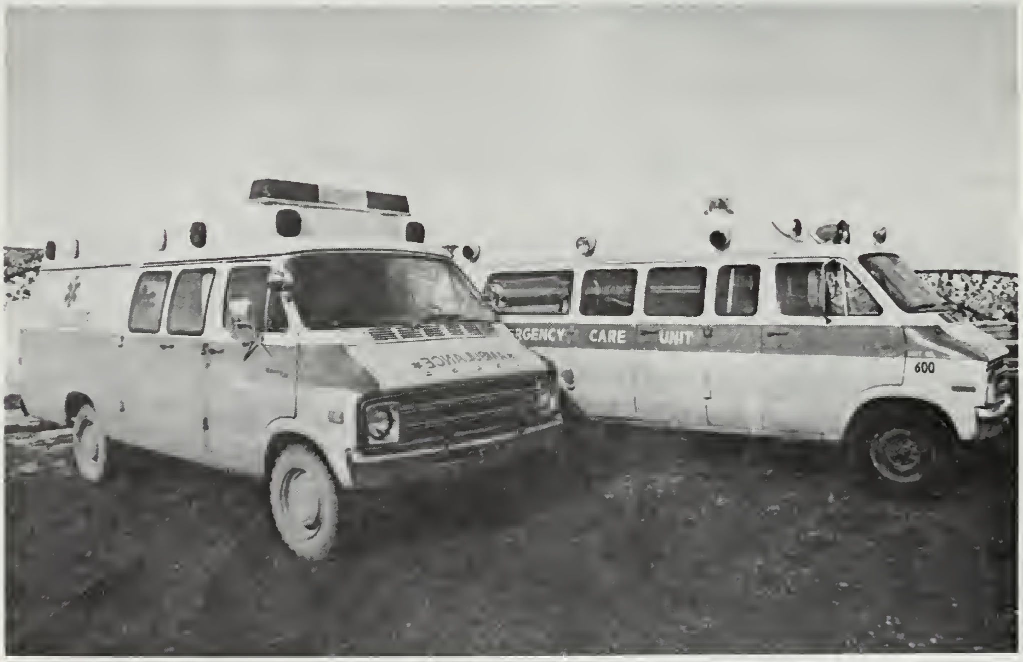


FIGURE 6-2-2
TRACT C-a AMBULANCES

Following are accident statistics for Tract C-a for the four quarters of 1978:

Period	Employee Man-Hours	Recordable Injuries/ Illness	Days Lost	Incidence Rate	Severity Measure	Injury Index
1st quarter Jan, Feb & March	45,349	4	11	17.64	48.51	.86
2nd quarter Apr, May & June	93,232	8	19	17.16	40.76	.70
3rd quarter July, Aug, Sept	85,120	7	21	16.45	49.34	.81
4th quarter Oct, Nov, Dec	110,259	2	5	3.63	9.07	.03
Year	333,960	21	56	12.57	33.54	.42

$$\text{Incidence Rate} = \frac{\text{No. of recordable injury/illness cases x 200,000}}{\text{Exposure or Total Employee-Hours}}$$

$$\text{Severity Measure} = \frac{\text{No. of Lost Workdays x 200,000}}{\text{Exposure or Total Employee-Hours}}$$

$$\text{Injury Index} = \frac{\text{Incidence Rate x Severity Measure}}{1000}$$

Safety in the mining area has been covered in Section 3, Part 2.4. Fire prevention techniques are covered in the next chapter in this section.

2.3 INDUSTRIAL HYGIENE PROGRAM

An industrial hygiene program for Tract C-a developed during 1978 is designed to be performed independently of other safety, health and environmental programs. This program covers all industrial hygiene concerns and activities related to shaft sinking, station and level development, development of combustion air and product separator systems, underground haulage, primary crushing, hoisting, surface haulage, mine drainage, and mine ventilation.

Major industrial hygiene and radiation health concerns for this program are: (1) airborne contaminants such as hydrogen sulfide, ozone, carbon monoxide, phenolic compounds, welding fumes, trace metals, organic solvents, and many others; (2) occupational dust (free silica) exposures; (3) occupational noise exposures; (4) potential ionizing radiation hazard from radon daughters in underground mines; (5) proper and adequate personal protection, especially respiratory protection; (6) sanitation and personal hygiene; and (7) requirements for employee training and for documentation and record keeping.

In each of the above areas, the applicable governmental regulations and mandatory health standards were cited and reviewed. Then, existing industrial hygiene activities and capabilities were evaluated. Finally, the required improvements were incorporated and the program commenced.

An industrial hygiene survey was conducted at the mining site of RBOSC on October 24 through 26, 1978. Work place concentrations of air contaminants measured included welding fumes (chronium, cadmium, zinc, lead and iron), organic vapors (n-hexane, benzene, toluene, xylene, and total hydrocarbons), arsenic, respirable dusts and free silica, hydrogen sulfide, sulfur dioxide, nitrogen oxides, ozone, methyl mercaptan, carbon monoxide and carbon dioxide. Results of the study are currently being reviewed for statistical validity. Another survey is scheduled for March 1979.

2.4 TOXICOLOGY STUDIES

The toxicology study program as presented in the DDP was based on an evaluation of expected materials and potential exposures to be found in the MIS process. Testing procedures are designed to evaluate toxicity and health risk for these materials:

- Extensive chemical characterization and studies on all materials, solids and liquids, as they become available from Tract C-a. Results of these studies will be compared with identical studies completed through the API on other oil shale materials to determine whether Tract C-a materials do or do not closely resemble the API samples.
- If Tract C-a samples closely resemble the API samples chemically, then minimal toxicity testing will be necessary on Tract C-a materials such as raw shale ore, processed shale and raw shale oil. If a close chemical resemblance does not exist, then more extensive toxicity testing will be necessary. Evaluations in either case will allow determination of possible health effects on workers mining and rubblizing raw shale ore, producing shale oil and handling related waste.
- Determine the potential, if any, for contamination of the groundwater aquifers upon abandonment of the underground retorting activities.

Raw shale ore has been collected during shaft sinking on Tract C-a, drummed and shipped to Standard Oil Company's Naperville Laboratory for initiation of the program.

The first step of RBOSC's research program will be to chemically analyze the raw and processed shale (Tract C-a source) to identify and quantify, if possible, fluorides, toxic heavy metals, radioactivity, free silica content and polynuclear aromatic content. This will allow comparison with oil shale materials used by others in ongoing toxicology studies.

If the basic characteristics of RBOSC shale material is similar or falls within an acceptable range in composition to the material that is being tested by others, RBOSC will rely on data produced by these other studies. If Tract C-a materials vary significantly, RBOSC will initiate steps to satisfy the second objective listed above.

The RBOSC test program utilizing Tract C-a material is to start in late 1979, extend through 1981 and be completed in 1982.

CHAPTER 3
FIRE PREVENTION AND CONTROL

3.1 MANAGEMENT AND TRAINING

The fire prevention and control program is under the auspices of the Safety Department and is directed by the Senior Safety Supervisor. A Fire Brigade Program has been conducted requiring members to have 40 hours of fire-fighting training. This covers the areas of ventilation, fire streams, ropes and ladders, and underground fire-fighting procedures. The underground procedures include rappelling into the shaft area with protective equipment, establishing fire curtains and extinguishing the blaze.

Each contractor is required to form and implement his own fire-prevention and fire-fighting program with the assistance of the Safety Department. They are also required to adhere to all applicable regulations regarding prevention of fire hazards and in dealing with flammable or combustible materials and explosives and practice good housekeeping. The contractor must supply all necessary equipment such as fire extinguishers at required locations.

3.2 FIRE PREVENTION AND CONTROL EQUIPMENT AND PROCEDURES

A. Equipment - A Fire Water Pump House with diesel and electric equipment is being constructed on tract. This is shown in Figure 6-3-1. This will serve the mine service and contractor area, generator and subcontractor area, and the process area. Construction was started in June 1978 and was about 80% complete by year-end. A storage capacity of 500,000 gallons minimum will be reserved in the West Retention Pond for this purpose. The East Retention Pond and the Reinjection Water Surge Tank will be secondary fire protection water supplies.

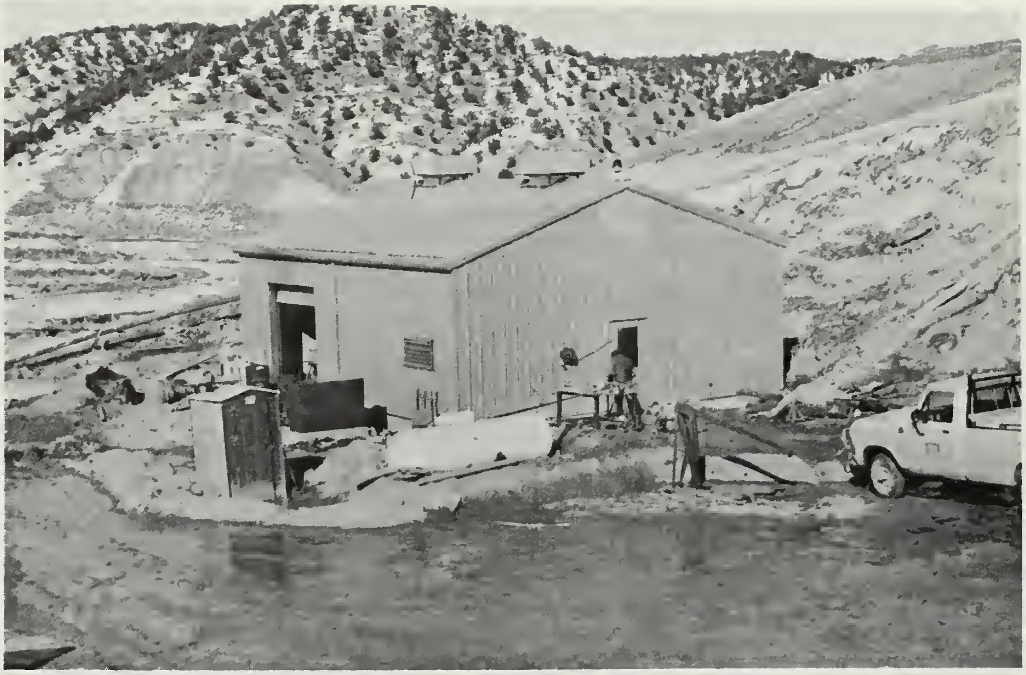


FIGURE 6-3-1
FIRE WATER PUMP HOUSE

The surge tank will have a minimum of 170,000 gallons reserved for fire protection. If necessary, reinjection could be temporarily stopped or reduced to augment the supply of fire protection water in the West Retention Pond. The surge tank is shown on Figure 6-3-2.

One diesel-driven pump and one electric-motor-driven pump were mechanically installed in the fire water pump house in October 1978. The pumps will have the capability of supplying 750 gpm at 125 psi water pressure to the tract fire hydrant system. These pumps will not be in full service, however, until the West Retention Pond construction and electric power installation are completed. The electric-driven fire pump will start automatically when the fire loop pressure drops to a set level. The backup diesel-driven pump will start automatically if the electric pump fails.

Mobile fire-fighting equipment consists of a fire truck, fire extinguishers, axes and ladders. A 1969 International Midship pumper truck was delivered

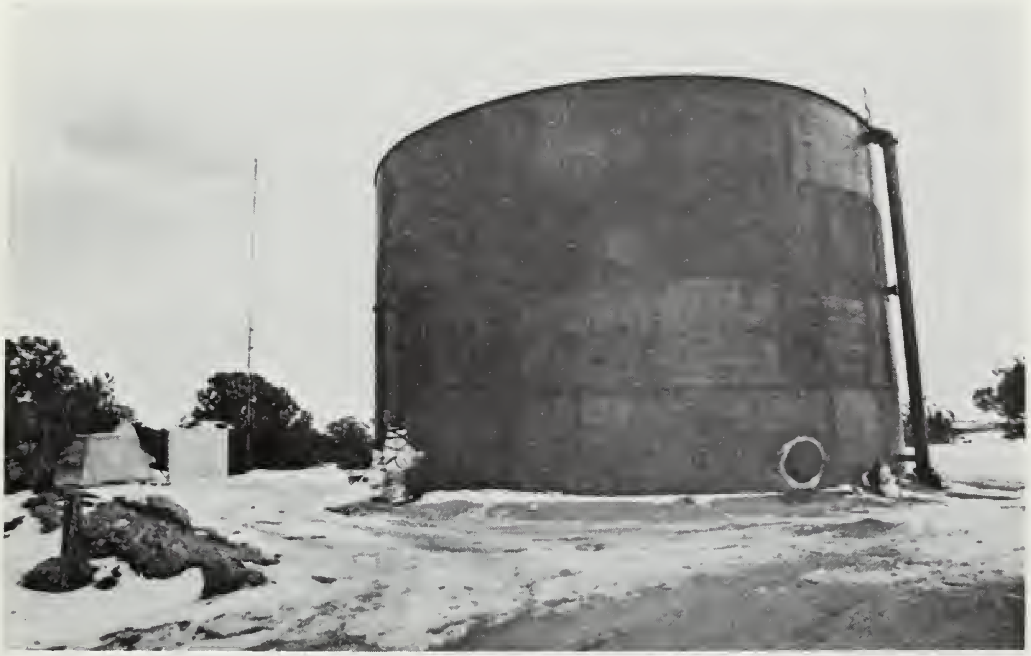


FIGURE 6-3-2
500,000 GALLON WATER TANK

in March 1978 and is located on tract. It is capable of pumping 750 gpm through 2000 feet of hose. In addition, the fire truck carries a supply of foam for fighting fuel fires and has a hard-suction capability for drawing water from a non-hydrant water supply such as stream or pond. The fire truck is shown in Figure 6-3-3.

Fire extinguishers are placed in every company vehicle located on tract and in strategic locations around the tract. These are posted for easy access. Also on hand as regular fire fighting equipment are axes and ladders.

B. Procedures - In addition to normal fire preventive measures in the mine, special precautions are taken during times of blasting and hot work such as welding. Before blasting can take place, a quality control inspector must make a gas test to ensure that gases are not present in a level sufficient to permit an explosion. In addition, before hot work can take place on any shift, the appropriate gas testing must take place

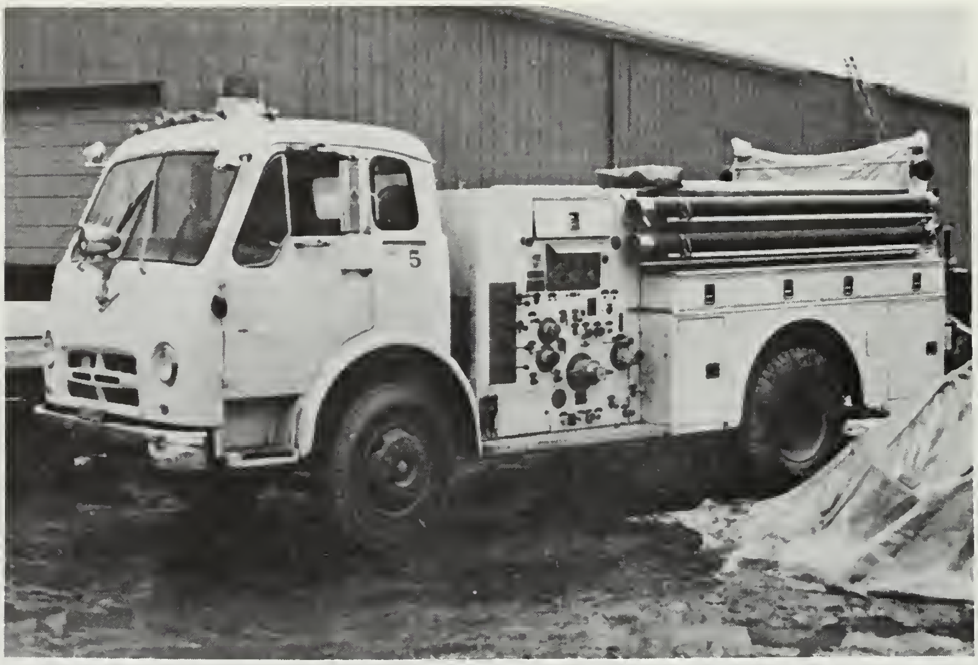


FIGURE 6-3-3
TRACT C-a FIRE TRUCK

before a hot work permit will be issued. Any employee performing welding work, whether underground or on the surface, is required to wear protective equipment.

A bell alarm signal system is utilized in the shaft to alert surface people to an emergency in the shaft. All underground employees receive training on evacuation procedures.

Signs posting the locations of fire extinguishers are prominently displayed. "No Smoking" signs are displayed in the shaft areas and areas where flammable and combustible materials are stored. All tanks dispensing fuels are located at required distances from buildings. The area is posted with signs indicating storage of flammable substances and precautions to be taken while dispensing the fuel. A fuel island was under construction on tract at the end of 1978 near the Generator Building to act as permanent storage for fuels now temporarily stored.

A member of the Safety Department trained in fire prevention procedures makes a periodic inspection at least once a month of office, warehouse and shop areas to ensure compliance with all applicable regulations, Fire Protection Association codes and good housekeeping practices.

In accordance with AOSO requirements and a Colorado Air Pollution Control Division (CAPCD) permit, open burning of slash from the construction area is done under strict control. Procedures and precautions include such measures as burning only when the fire danger is low, burning in localized, cleared areas, attended burning and having the fire truck present while burning is taking place.

CHAPTER 4
AIR QUALITY CONTROL

4.1 DUST CONTROL

Intensive dust control measures have been employed on Tract C-a to control fugitive dust. Based on numerous conversations with industry and government personnel, several chemicals for dust control were tested and various control techniques were employed. In addition, large quantities of water were used on the work site.

Dust problems were broken down into two types: (1) traffic and construction-generated dust (such as on dirt roads which are numerous on Tract C-a) and earthwork-generated dust from heavy mobile construction equipment; and (2) windblown dust.

RBOSC has been using water for fugitive dust control on the work site. The areas watered include access and haul roads, mine shaft area, visitors center, retention ponds, borrow pits, warehouse, and laydown area. The water was applied by water-sprinkling trucks. Down-spouts on reinjection water pipelines were installed at five different locations on Tract C-a for filling the water trucks. A filling pond is also used for truck loading purposes when required. For the reporting period, water was applied in the following amounts:

- last quarter 1977 - 336,000 gallons
- first quarter 1978 - none, because of snow cover
- second quarter 1978 - 7,125,000 gallons
- third quarter 1978 - 7,939,503 gallons
- last quarter 1978 - 1,885,114 gallons (early snow cover)

At one time during late summer, five water trucks were employed for fugitive dust control. Figure 6-4-1 shows a water truck watering the road.

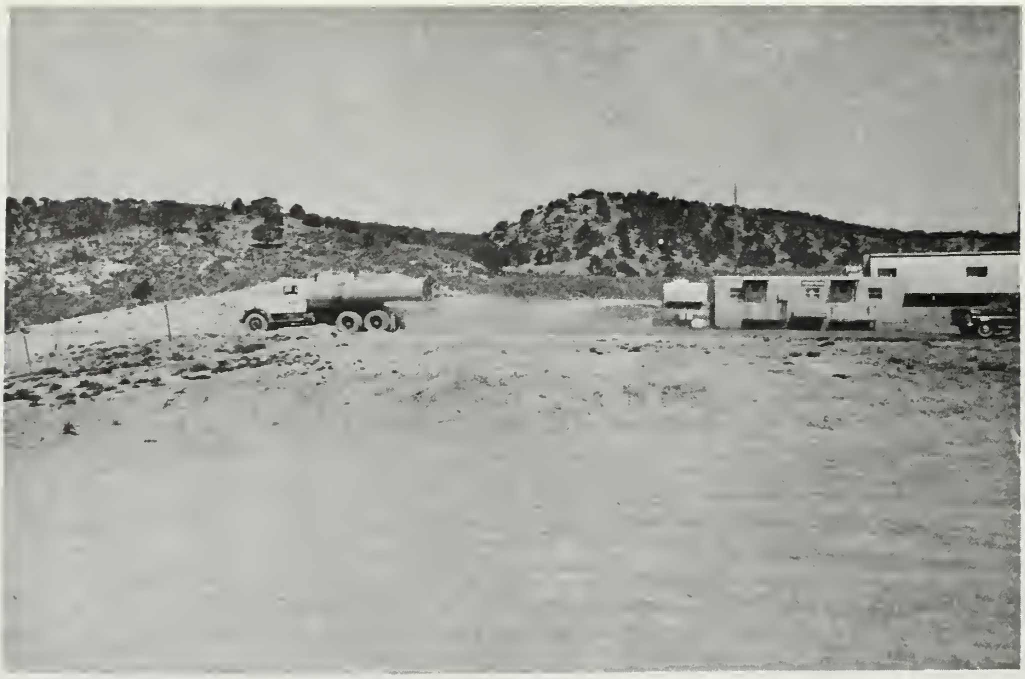


FIGURE 6-4-1

WATER TRUCK WETTING ROADS

In addition to the work site area, dust control water applications were also made on Rio Blanco County Highway 24. There were 613,000 gallons applied during the third quarter of 1978. The county road building contractor applied water during the fourth quarter.

After construction of the access road and plant and mine benches, approximately 41,000 tons of gravel were hauled from the White River to Tract C-a. This gravel was applied in a 6-inch layer on the access road and a 3-inch layer was placed over the entire mine bench and over most of the plant bench area. The application of gravel greatly reduced both traffic-generated and windblown dust problems. Also, the Hunt Club clay pit area was surface flooded with water for dust control before and during the truck loading and hauling to the retention ponds for construction of the liner.

During 1978, various chemical palliatives were used for control of fugitive dust. The chemicals employed were termed dust suppressants, palliatives, stabilizers, surfactants, etc. Three different dust palliative agents were applied to haul roads, top-soil piles, ore pile, mine and plant bench slopes, road berms, borrow pits, temporary helicopter landing sites, and other disturbed areas. Table 6-4-1 summarizes the fugitive dust palliative applications on Tract C-a. Coherex is a dust control agent, Nalco 8820 is a soil stabilizer and Bio Cat 300-1 is used as a road stabilizer and dust suppressant. During the second quarter of 1978, 1815 gallons of palliatives were applied; 4620 gallons were applied in the third quarter 1978; and 200 gallons were used in the last quarter of 1978. Of the three chemicals, Coherex has yielded the best results to date.

In order to minimize dust generation caused by vehicular movement, speed controls were imposed. Speed limits on Tract C-a were posted at 30 mph maximum. In congested and construction areas the speed limit was reduced to 20 mph.

Over $80,000 was spent on fugitive dust control during June through September 1978, excluding gravel costs. For the month of August 1978 alone, over $30,000 was spent.

Future plans for dust control include continued watering, use of palliatives, revegetation, and strict enforcement of speed limits. Coherex and the CSS-1 will be applied to the roads during 1979. Consideration is being given to paving the main access road. As mentioned, Coherex has proven to be an economically effective chemical dust control agent, whereas CSS-1 is still being tested. County Road 24 will be paved by Rio Blanco County in the spring of 1979. The paving will greatly reduce the dust generated by road traffic. In addition, revegetation for dust control will continue in areas where construction has been completed.

TABLE 6-4-1

FUGITIVE DUST PALLIATIVE APPLICATION, TRACT C-a

Application Date	Agent (Gallons)	Mixing Ratio (Water to Agent)	Location
July			
7-?	Coherex (165)	18:1	Haul Road
August			
8-24	Coherex (165)	18:1	Haul Road
8-25	Coherex (210)	14:1	Haul Road
8-29	Coherex (360)	8:1	Road Berms
8-30	Nalco 8820 (180)	17:1	Access Road Clay Pit - 2 Acres
Total for August 24-31: 915 gallons of agent.			
September			
9-1	Coherex (630)	14:1	Access Road Clay Pit - 3.5 Acres
9-5	Coherex (750)	20:1	Access Road Clay Pit - 6 Acres
9-6	Cohorex (180)	17:1	ROM Area
9-7	Coherex (180)	17:1	Access Road Clay Pit
9-7	Coherex (900)	10:1	Corral Gulch Road
9-7	Coherex (180)	17:1	ROM and West Bench
9-8	Coherex (180)	17:1	Top Soil Piles Near ROM
9-8	Biocat 300-1 (240)	25:1	GS-6 Road
9-11	Nalco 8820 (30)	100:1	Top Soil Pile "C"
9-11	Coherex (210)	14:1	Unknown
9-11	Biocat 300-1 (30)	100:1	Haul Road Excavation
9-15	Biocat 300-1 (30)	100:1	Water Tank Area
Total for September 1-20: 3,540 gallons of agent.			
October			
10-31	CSS-1 (200)	7.5:1	250' of one side of Haul Road

4.2 BURNING CONTROL

The burning control requirements discussed in the previous chapter also affect air quality. There is no open burning during periods of air pollution emergency or alert. Portable fans are used to ensure complete burning. As soon as the burning is complete, the fire is completely extinguished and not allowed to smolder.

CHAPTER 5

OIL AND HAZARDOUS MATERIAL CONTROL

The facilities for storage of large quantities of product oil, diesel fuel and other chemicals were designed to minimize the possibility of spillage. During 1978, Section 7D of the Oil Shale Lease Environmental Stipulations (concerning storage and handling of oil and hazardous material) was amended. All oil or hazardous material is stored in a containment area where the volume of the containment structure is at least 110 percent of the largest tank plus displacement of all other tanks in the compound below the dike height or liquid level. The fuel tanks will be installed in 1979. In addition, the volume is sufficient for maximum trapped precipitation and runoff which might be impounded at the time of a spill.

When the MDP becomes operational, a spill contingency plan will be prepared which will include procedures for notification, containment, repair and cleanup of spills.

CHAPTER 6

LAND REHABILITATION AND EROSION CONTROL

6.1 GENERAL

In compliance with lease stipulations and Colorado Mined Land Reclamation Board (CMLRB) Permit requirements, RBOSC has instituted a reclamation program on Tract C-a to: reclaim disturbed areas, control fugitive dust, erosion and conserve natural soils. Additionally, RBOSC submits an annual report to the Mining Supervisor in compliance with 43 CFR Part 23.10 as appended to the Tract C-a Oil Shale Lease as well as an annual report to the CMLRB as per Permit Number 77-497, dated March 6, 1978.

This section satisfies 43 CFR Part 23.10 by providing the following information:

- Identification of area affected by operations in the previous year.
- Statement of number of acres disturbed and number of acres reclaimed during the year.
- A description of the methods utilized for reclamation (results can't be reported until after the first growing season).
- A description of reclamation work remaining to be done.
- Planting report.

Grading and back-filling procedures were approved by the Mining Supervisor as a part of the DDP and were reviewed as a part of the Information for Bid document released in connection with the 1978 fall reclamation activities. On-site efforts were monitored by the AOSO staff.

In addition to reclamation activities, RBOSC has carried out a 3-year experimental revegetation program to "demonstrate technology necessary for the successful revegetation of disturbed lands" as per Section 11(L) of the lease environmental stipulations. Results of this program are presented in Part 6.4 of this chapter.

6.2 SOIL CONSERVATION AND EROSION CONTROL

Soil removed was stockpiled according to provisions of the DDP as indicated in Figure 6-6-1. These soils stockpiles were stabilized in 1978 by planting fast growing plants including yellow sweet clover, barley, western wheat grass, and Luna pubescent wheat grass. Wind erosion was prevented by application of dust suppressants to selected areas (see Section 6, Chapter 4.)

6.3 RECLAMATION

One hundred fifty-four acres were disturbed during 1977-1978. The locations of the disturbed acreages are outlined in Figure 6-6-1. Approximately 60 acres were revegetated on Tract C-a during November 1978 (Table 6-6-1). Location of reclaimed areas listed on Table 6-6-1 are shown on Figures 6-6-1 and 1-2-4.

Table 6-6-1 indicates areas as either temporarily or permanently revegetate Areas temporarily revegetated are areas which are expected to be disturbed again, e.g., mine service/plant site areas. These areas were revegetated to reduce fugitive dust. Permanent areas are those where no further disturbance is anticipated. Temporary areas were graded to the extent necessary to permit revegetation. Permanent areas were graded, topsoil replaced, and revegetated. In addition, five water bars were constructed along the Old Airplane Ridge Road Segment to prevent erosion along the drainages which cross the disturbed areas.

Revegetation activities at Tract C-a were conducted during November 1978 but were suspended in late November due to weather conditions. Job

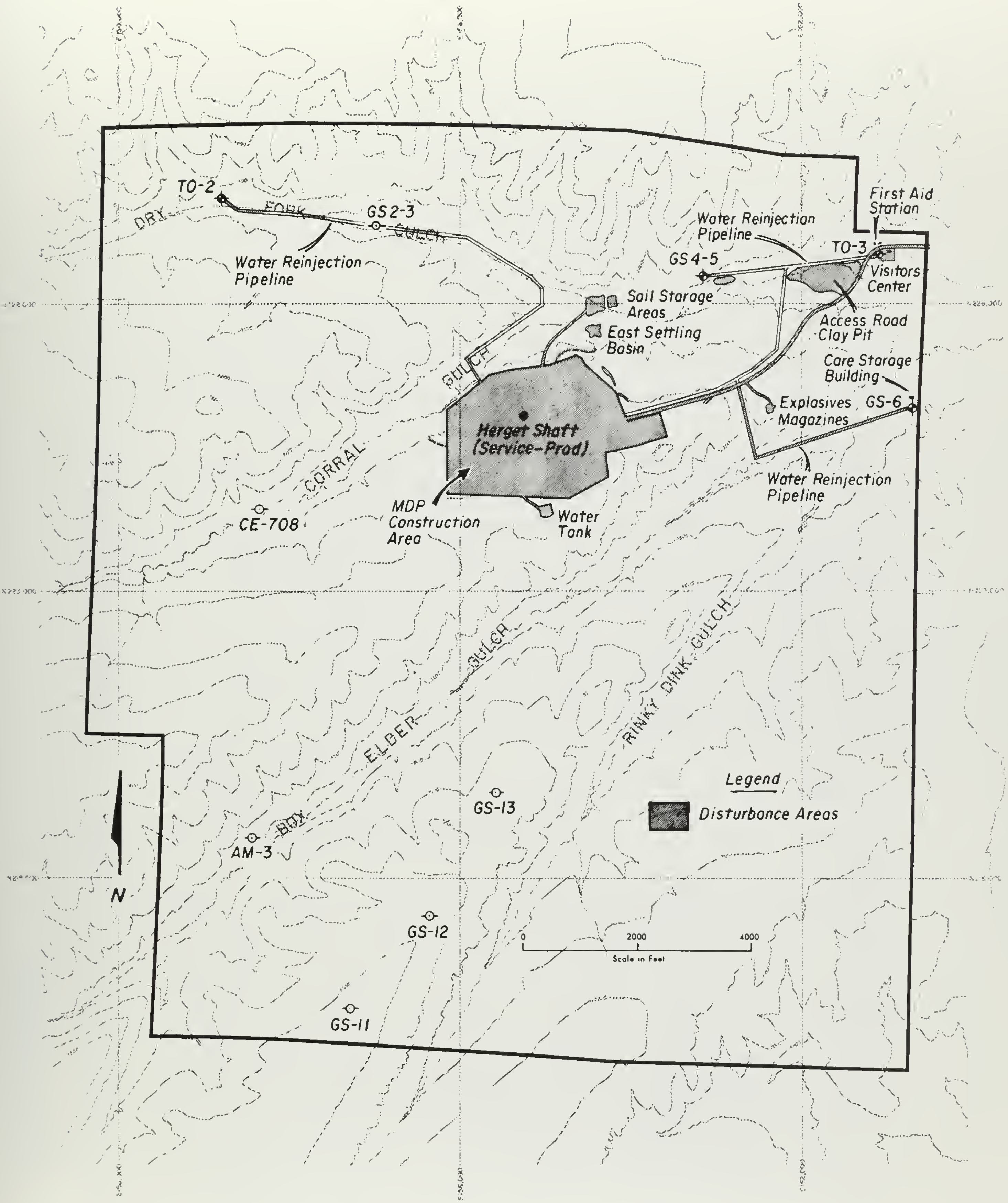


FIGURE 6-6-1
TRACT C-a DISTURBED AREAS, 1977-78

TABLE 6-6-1

AREAS DISTURBED TO DATE, REGEGETATED IN 1978 AND ESTIMATED AREAS TO BE DISTURBED AND RECLAIMED IN 1979

Disturbed Area	Disturbance Type	Disturbed			Reclaimed	
		1977	1978	1979	1978	1979
Mine Service Area, Retention Ponds & Plant Site	Major	48	3			
Retention Ponds					8^{T}	
Plant Sideslopes					12^{T}	
Area Near Hunting Club					2^{P}	$1^{P,1}$
Area Between Water Tank & Plant Site					5^{P}	
Diversion System					3^{T}	$3^{T,1}$
Settling Basins					1^{T}	$1^{T,1}$
Equipment Yard					3^{P}	
Area Near Substation						$1^{T,1}$
Access/Service Roads	Moderate	10	29		6.5^{P}	$6.5^{P,1}$
ROM Disposal Area	Major		13		10^{T}	
Soil Storage (1, 2, 3)	Major		3		3^{T}	
Powder Magazine	Moderate	1	3			
Water Reinjection System	Moderate		13	20	7^{P}	2^{P1}, 20^{P}
Transmission Line	Moderate		5			
Natural Gas Pipeline	Moderate			5		5^{P}
Reservoirs & Soil Pits (A,B,C,D)	Major			50		50^{T}
Access Road Clay Pit			10			
Hunting Road Clay Pit			15		2^{P}	
Monitoring Facilities	Moderate		1			$1^{T,1}$
Scrubber Blowdown Ponds	Major			10		
Scrubber Blowdown Pond Pipeline	Moderate			4		
Airplane Ridge Road Relocation	Moderate			8		
Old Airplane Ridge Road Segment						$9^{P,1}$
TOTALS		59	95	97	62.5	99.5

---

[1] Area scheduled to be revegetated during November, 1978; due to November weather conditions revegetation rescheduled for Spring, 1978

LEGEND:
T = Temporary Revegetation
P = Permanent Revegetation

completion was approximately 70% of that scheduled for 1978, therefore, the remaining activities are scheduled for Spring 1979.

A summary of seeding activities performed during 1978 is presented in Table 6-6-2. The seed mixtures used are listed in Table 6-6-3. Areas on and near the plant site, e.g., side slopes of ponds, side slopes of the plant site, were temporarily reclaimed although these locations were not scheduled for revegetation during 1978. Revegetation activities interrupted during November 1978 will be completed as outlined in Table 6-6-4.

No fertilizers, organic material or soil conditioners were used during the 1978 activities. A nitrogen-phosphorus fertilizer will be applied to the revegetated areas during Spring 1979 as described in the RBOSC CMLRB Permit Application. An evaluation of the 1978 reclamation efforts will be performed during 1979 and included in the 1980 Annual Report.

Approximately 100 acres are expected to be disturbed during 1979 (Table 6-6-1). The areas expected to be disturbed during 1979 include the water reinjection system, reservoirs and associated soil storage, scrubber blowdown ponds, and Airplane Ridge Road relocation.

6.4 EXPERIMENTAL REVEGETATION PROGRAM

In 1979, RBOSC completed the 3-year revegetation experimental program initiated in July 1975. The revegetation experiments initiated in 1975 (locations R_1 and R_2 on Figure 6-6-2) were designed to investigate revegetation techniques for surface disturbances. Techniques investigated were: species adaptability; mulch type; timing of fertilizer application; and effect of aspect. The revegetation experiments initiated in 1976 (location R_3) were designed to determine the effectiveness of an artificial soil profile and to determine the feasibility of establishing native vegetation on processed shale. The experimental treatments included substrate types, mulch types, seeding intensity, and shrub establishment techniques.

TABLE 6-6-2

SUMMARY OF SEEDING AND MULCHING ACTIVITIES PERFORMED DURING 1978 AT TRACT C-a

Disturbed Area	Seeding Mixture	Seeding Method	Hydro-mulched	Seeding Rate (lbs PLS/acre)
Access Road Berms	1	H	x	38
Water Reinjection	1	H	x	38
West Settling Basin	2	D		16
Ore Disposal Area	2	D		16
Soil Storage	2	D		16
Plant Site/Mine Service Area				
Blowdown/Retention Ponds	2	H	x	32
Plant Side Slopes	3	H		50
Area near Hunting Club	1	D	x	19
Area between Water Tank and Plant Site	1	D	x	19
Diversion System	2	H,B		32
Equipment Yard	1	D		19
Reservoirs/Soil Piles				
Hunting Road Clay Pit	2	D		16
Meteorological Site 4	1	D		19

Seeding mixture - see Table 6-6-3
PLS - Pure live seed
H - Hydroseed
D - Drill
B - Broadcast

TABLE 6-6-3

THREE SEED MIXTURES USED FOR RBOSC REVEGETATION ACTIVITIES DURING FALL, 1978

Seed Mixture	Plant Species		Seeding Rate* Approximate (lbs PLS/acre)***
1 - Permanent	Luna pubescent wheatgrass		2.5
	Western wheatgrass		3.5
	Sodar streambank wheatgrass		2.0
	Indian ricegrass		1.5
	Green needlegrass		1.5
	Manchar brome		1.5
	Cicer milkvetch		1.5
	Madrid yellow sweetclover		0.75
	Lewis flax		1.0
	Winterfat		1.0
	Fourwing saltbush		1.0
	Bitterbrush**		1.0
		Total	18.75
2 - Temporary	Yellow sweetclover		1.0
	Barley		1.0
	Western wheatgrass		6.0
	Luna pubescent wheatgrass		8.0
		Total	16.0
3 - Temporary	Yellow sweetclover		4.0
	Crested wheatgrass		8.0
	Barley		8.0
	Luna pubescent wheatgrass		5.0
		Total	25.0

---

*Based on drilling rate; rate for broadcasting is doubled.

**Bitterbrush was included in seed mixture for Airplane Ridge Road and areas near the Hunting Club.

***PLS - pure live seed.

TABLE 6-6-4

SEEDING AND MULCHING ACTIVITIES SCHEDULED FOR FALL, 1978 TO BE COMPLETED SPRING, 1979

Disturbed Area	Seeding Mixture	Seeding Method	Hydro-mulch	Seeding Rate (lbs PLS/acre)
Access Road Berms	1	H	x	38
Airplane Ridge Road	1	D	x	19
Reservoir/Soil Piles				
Access Road Clay Pit	1	D	x	19
Water Reinjection	1	H		38
East Settling Basin	2	D		16
Monitoring Facilities	2	B		32
Plant Site/Mine Service Area				
Area near Hunting Club	1	D	x	19
Diversion System	2	B		32
Area near Substation	2	B		32

Seeding mixture - see Table 6-6-3
H - Hydroseed
D - Drill
B - Broadcast
PLS - Pure live seed

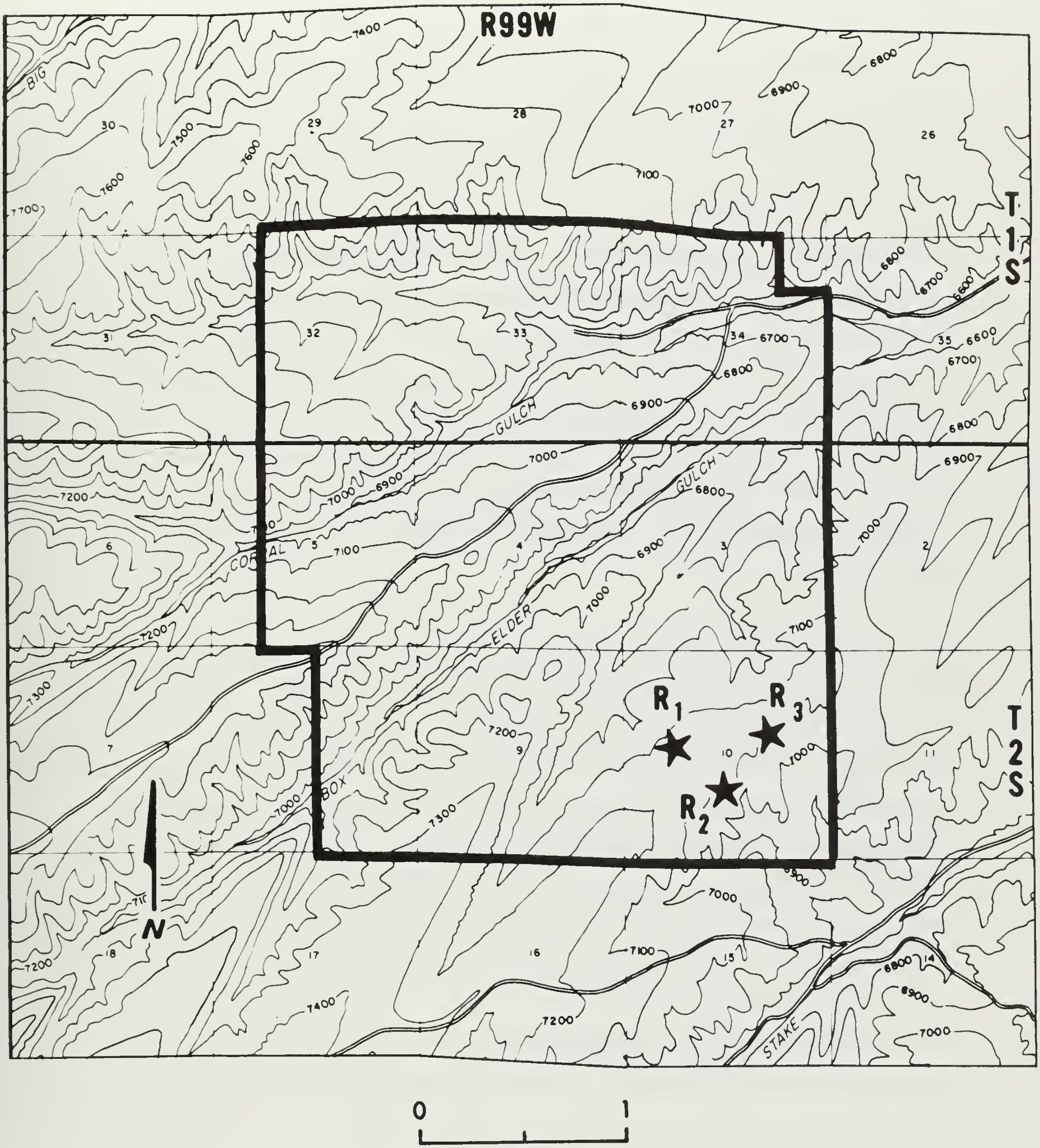


FIGURE 6-6-2

LOCATION OF REVEGETATION TEST PLOTS (R_1, R_2 AND R_3)

Percent cover and aboveground biomass were measured at R_1 and R_2 during the third growing season (1978). Percent cover was measured by visual estimates of foliar coverage within the 1 x 1 m permanent subplots within each treatment plot. Biomass was determined by harvesting aboveground vegetation within the permanent subplots, air-drying for 30 days, and weighing. An Analysis of Variance (ANOVA) was performed for the percent cover and biomass data to determine if significant differences existed among mulch and fertilizer treatments or plant species. Percent cover estimates during 1978 indicated that forbs were the dominant life form at R_1 and R_2 and that total cover during 1978 was similar to that estimated during 1977. Invader species, e.g. Russian thistle, decreased in percent cover while planted species increased in abundance. The biomass of planted grass and forb species was similar to estimates made for upland sagebrush during the terrestrial baseline studies in 1975.

Percent cover, height and diameter of containerized shrub seedlings were measured at R_3 during the second growing season (1978). Percent cover was measured by the method described above for R_1 and R_2. An ANOVA was performed for the percent cover data to determine if significant differences existed among substrate, seeding intensity, and mulch treatments or plant species. Percent cover at R_3 increased approximately 50 percent from the percent cover measured in 1977. The difference in percent cover between 1977 and 1978 resulted from an increase in planted species. Percent cover of planted species on R_3 is greater (38%) than that found on R_1 and R_2 (19% and 16%, respectively). Containerized shrub seedling studies indicated that fourwing saltbush, winterfat, big sagebrush, and bitterbrush were the most successful of tested native species.

Soil moisture measurements (by gravimetric technique) were made at R_1, R_2, and R_3 during June, August and October 1978. The measurements indicate that soil moisture levels generally decreased during the growing season which corresponds to the smaller precipitation amounts received during the late summer of 1978. Soil conductivity measurements (1:2 soil -

water extract) were made at 0, 25, and 50 cm depths at R_3 to investigate the effectiveness of the artificial soil profile to inhibit upward capillary movement of salts and toxic elements. Soil conductivity levels at R_3 have remained essentially unchanged since 1976 when the experiment was initiated.

The objectives of the RBOSC experimental revegetation program were to investigate available revegetation technology and to determine the feasibility of successfully revegetating the disturbances expected to result from construction and waste disposal on Tract C-a. Thus, two experiments were designed: one to investigate reclamation procedures for surface disturbances (Locations R_1 and R_2) and the other for disturbances resulting from disposal of processed shale (Location R_3). The experimental programs were designed to collect three years of biological and soils data.

The results of the experiments initiated in 1975 and 1976 indicate that three years is the minimum length of time necessary to assess the effectiveness of the tested treatments. Percent cover and biomass data appear to be the most useful of the data collected. Percent cover is a parameter which can be easily measured annually and provides a good indication of changes in species composition and species abundance which is necessary to evaluate successional changes. Biomass data are needed for comparison of revegetation results to baseline studies in accordance with Section 11 of the lease stipulations.

The emergence and survival density data were less useful in evaluating field results and it is suggested that the effort required to collect such data is excessive if not prohibitive. Identification of grass seedlings was also a substantial problem since a mixture of grasses was seeded. Similar information could be obtained in a more cost effective manner from the percent cover data.

The soil moisture measurements provided useful information in determining the drought conditions to which the seedlings were subjected. Continued collection of soil moisture data for R_1, R_2, and R_3 would probably not provide any information which cannot be interpreted from precipitation data.

Soil conductivity data at R_3 provide the most important means of evaluating the effectiveness of the artificial soil profile. It is essential that annual conductivity measurements be continued at R_3 to determine the effectiveness of the artificial soil profile over the long term.

The success obtained using a mixture of grasses, forbs, and shrubs is encouraging since it appears that a diverse plant community can be achieved more rapidly than by planting only grasses and forbs. The experimental results also indicate that numerous species can be used successfully to revegetate disturbances on Tract C-a although slope aspect should be considered when selecting a seed mixture.

The results indicate that there are differences in plant germination and establishment among the mulches tested and that the use of mulch improves success. The timing of fertilizer application does not appear to significantly affect establishment but the results indicate that fertilizer does enhance establishment of weedy species on disturbed areas.

Seeding rate appears to be the most important single factor in determining revegetation success.

Shrub establishment investigations suggest that a combination of plantings may be productive in establishing shrubs on Tract C-a. Winterfat and fourwing saltbush can be most economically grown by direct seeding. Big sagebrush and bitterbrush can be grown successfully from containerized seedlings.

The results obtained to date at R_3 indicate that an artificial soil profile is a feasible method to establish native vegetation on a processed shale disposal pile. The three to four foot profile provides a growth medium with sufficient depth and an acceptable chemical quality to support plant species similar to existing vegetation on Tract C-a.

CHAPTER 7

SOLID WASTE CONTROL

At the present time, a private disposal service is hauling trash from Tract C-a to the landfill at Meeker, Colorado. The disposal service has supplied 2 and 3 cubic yard bins with lids to prevent wind pickup and scattering. Because of the probability that the Meeker site will not be adequate for receipt of solid waste throughout the life of the MDP, a Tract C-a landfill concept has been tentatively approved. It will probably be constructed and put into service in 1979 after site testing and design approval by regulatory agencies.

CHAPTER 8
FISH AND WILDLIFE MANAGEMENT PLAN

The RBOSC Fish and Wildlife Management Plan is designed to minimize damage to fish and wildlife and their habitats by assuring minimal land disturbance, by providing alternate habitat, and/or by preventing unnecessary stress caused by human activity. To date, disturbance of wildlife habitat has been restricted to less than 160 acres, making it premature to institute habitat alterations. Mitigative measures to lessen potential stress due to human activity are practiced on a regular basis, however, as discussed below.

8.1 LAND DISTURBANCE CONTROL

Disturbance of land during development activities has been in accordance with stipulations set forth in the Colorado Mined Land Reclamation Board Permit and in the DDP. These stipulations provide for the confinement of disturbance to identified areas. Disturbance outside of these areas as a result of off-road vehicle use or movement of highway equipment over undisturbed lands has been restricted. As a result, development activities to date have resulted in disturbance of less than 160 acres. Of this total acreage, approximately 60 acres were reseeded in the fall of 1978. An additional 25 acres will be planted this spring. Details were given in Chapter 6 of this section.

The minimization of disturbance in concert with prompt reclamation of disturbed areas has prevented major displacement of wildlife in the area. Feral horses and mule deer are regularly observed a short distance from the development area.

8.2 HUMAN DISTURBANCE CONTROL

Human disturbances to wildlife include road kills, hunting pressure and general harassment by people or pets. Increased numbers of humans on tract could result in aggravation of one or all of these disturbances. In anticipation of these problems, RBOSC has taken the following steps to mitigate the disturbances:

- Use of multi-passenger vehicles and car pools to transport workers to and from the tract and to reduce vehicle numbers on roads;
- Alerting workers and visitors that wildlife frequently cross the roadways abruptly without warning;
- Posting of speed control signs on tract to reduce speed and encouraging workers to reduce speeds on highways to tract;
- Conducting deer carcass counts to identify areas most likely to experience animal/vehicle collisions and to identify extent of deer loss;
- Providing information on hunting and fishing restrictions to workers and visitors to discourage illegal activities;
- Providing information relative to state penalties for harassment of wildlife by dogs or humans; and
- Restricting off-road vehicle use.

The success of these mitigation measures has been demonstrated by the continued utilization of the area by large game animals and other wildlife species and by the limited number of deer killed on roads since February 1978 (Table 6-8-1).

8.3 PUBLIC INFORMATION

Humans are frequently party to unintentional wildlife disturbances because of their failure to recognize the potential impacts of their activities. Examples of such disturbances include indiscriminate use of off-road vehicles (e.g. snowmobiles, motorcycles), introduction of unleashed pets, disposition of harmful trash or garbage where it is accessible to wildlife, and careless use of fire. The most direct and effective means of mitigating these impacts is to inform tract visitors

TABLE 6-8-1

MULE DEER CARCASSES COUNTED ALONG ROADS BY RBOSC PERSONNEL DURING 1978 FROM RANGELY TO TRACT C-a

Time Period	Number	Location
2/27/78 - 3/4/78	0	
3/5/78 - 3/12/78	0	
3/13/78 - 3/19/78	0	
3/20/78 - 3/26/78	0	
4/3/78 - 4/9/78	1	Highway 64 @ Milepost 38.5
4/9/78 - 4/16/78	0	
4/15/78 - 4/23/78	0	
4/23/78 - 4/30/78	0	
5/1/78 - 5/7/78	2	Highway 64 @ Milepost 40 Highway 64 @ Milepost 49.5
5/8/78 - 5/14/78	0	
5/17/78 - 5/21/78	0	
5/22/78 - 5/29/78	1	Highway 64 @ Milepost 24
5/28/78 - 6/4/78	0	
6/5/78 - 6/18/78	0	
6/19/78 - 7/4/78	1	Highway 64 @ Milepost 33
7/4/78 - 7/8/78	0	
7/10/78 - 7/16/78	1	Highway 64 @ Milepost 25
7/16/78 - 7/23/78	0	
7/23/78 - 7/30/78	1	Highway 64 @ Milepost 32.5
7/30/78 - 8/13/78	0	
8/13/78 - 8/20/78*	1	Highway 64 @ Milepost 38
8/20/78 - 8/27/78	0	
8/27/78 - 9/2/78	0	
9/3/78 - 9/17/78	0	
9/17/78 - 10/1/78	0	
10/22/78 - 10/29/78	0	
10/29/78 - 11/12/78	1	County Road 24 @ Milepost 4
11/12/78 - 11/13-78	0	
12/3/78 - 12/17/78	0	

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*Route 64 counts discontinued after August 20, 1978. Data thereafter represents only carcasses counted on County Road 24.

and workers that these activities can result in adverse impacts. To accomplish this, RBOSC provides an informative brochure to all visitors and new workers who enter the site. This brochure contains information on hunting and fishing regulations, lists wildlife likely to occur in the area, and discusses some of the impacts which can result when humans carelessly pursue their activities.

The frequency of habitat abuses by humans in the area is extremely low indicating a good degree of success of the Fish and Wildlife Management Plan. Continued monitoring of selected wildlife and their habitats will assure a continued success of the plan.

CHAPTER 9

PROTECTION OF OBJECTS OF HISTORIC AND SCIENTIFIC INTEREST

The only area known to contain potentially significant cultural resources on Tract C-a is a site designated as 5RB13 which lies in the southeast corner of the tract. This area has been nomimated to the National Register of Historic Places and was afforded protection by the BLM in a "Determination of Effect" in compliance with Section 106/2b of Executive Order 11593. RBOSC has protected this site from disturbance by issuance of instructions to tract supervisory personnel in the early fall of 1977 to avoid the site and by making available a map plainly depicting the protected area. This map has been posted in a prominent place on tract as a constant reminder of the protection required.

Additionally, workers have been instructed to report any finds of potential archaeologic or paleontologic significance to their supervisors immediately upon discovery. To aid in this, a set of photographs is posted at the tract showing representative artifacts discovered during the archaeological survey. Supervisory personnel are instructed to stop work to establish the significance of such a find. Also, tract personnel are instructed to be alert for the presence of fossilized plant and animal remains.

CHAPTER 10
AESTHETICS

Several practices were adopted to improve Tract C-a aesthetics. All buildings constructed during 1978 utilized sage green or beige siding to blend with the vegetation and/or soil color of the area. These buildings are shown in various photographs throughout this report.

In addition, areas such as the shaft ore disposal area and the Hunt Club office area were left with a buffer of trees around the facilities to provide a visual screen.

CHAPTER 11
SUBSIDENCE MONITORING

Thirty subsidence monuments were installed in 1978 over the planned MDP retorts and other areas on Tract C-a to monitor any effects on the land surface caused by dewatering and/or mining activities. Nineteen more monuments will be installed in the first quarter of 1979. The coordinates and elevations of each of the monuments were recorded upon installation. The monuments were constructed with 1-inch diameter steel reinforcing bars up to 10 ft. in length. These steel bars were driven through any soil cover and into the weathered shale bedrock as far as possible. The average soil depth is about three feet in the construction area. A steel pipe was then installed around the top three feet of the rebar to protect it.

The horizontal and vertical relationship of these monuments were referenced to a benchmark sufficiently distant from the MDP retort area to assure that the benchmark itself would not undergo any displacement due to the dewatering and/or mining activities. Subsequent re-surveying of these monuments on a periodic basis is designed to detect any changes in their horizontal and vertical positions, thus monitoring the area for subsidence. The monitoring schedule is highly dependent on weather conditions, especially during the winter.

Subsidence monitoring commenced in March 1978. The first 30 subsidence monuments installed on Tract C-a were re-surveyed in December 1978 and essentially no movement, either vertically or horizontally, had occurred.

SECTION VII

ENVIRONMENTAL ASSESSMENT & MOITORING

CHAPTER 1

INTRODUCTION

Since its inception in 1974, RBOSC has been conducting extensive environmental data collection programs. Between October 1974 and September 1976, two years of baseline data were gathered. From September 1976 through August 1977, interim environmental data were collected during the suspension discussed in Section 1, Chapter 1. In September 1977, RBOSC initiated their MDP Environmental Monitoring Program. The first report of MDP environmental activities (September - November 1977) was published in February 1978; the second report (December 1977 - May 1978) was published in September 1978. The third report describing MDP environmental activities is being submitted to the AOSO separately in several volumes. This report, RBOSC MDP Monitoring Report 3, presents data collected during the summer (June, July, August) and fall (September, October, November) seasons, discusses the data collected from December 1977 through November 1978, and compares MDP data with baseline and interim data.

The environmental activities carried out during the last year and a brief summary of findings are presented in this annual report. The reader is encouraged to consult the complete document for further information.

The RBOSC MDP Environmental Monitoring Program provides air quality, meteorology, terrestrial ecology, aquatic ecology, and hydrology data. Monitoring program designs were based on analysis of baseline and interim studies data, an assessment of probable developmental impacts, and recommendations from the AOSO. The current monitoring program is being conducted according to the RBOSC MDP Environmental Monitoring Program Scope of Work dated March 17, 1978. This scope of work reflects the environmental monitoring philosophy set forth in the DDP.

Air quality, meteorology, terrestrial ecology, and aquatic ecology studies described herein were conducted by NUS Corporation. Hydrology studies were carried out by Wright Water Engineers and the United States Geological Survey (USGS). Dames and Moore collected the visibility data, and Morrison-Knudsen, Inc. collected the noise data.

Volume 1 of the RBOSC MDP Monitoring Report 3 contains six sections as follows:

Section 1 - Introduction
Section 2 - Atmospheric Studies
Section 3 - Terrestrial Studies
Section 4 - Aquatic Studies
Section 5 - Hydrology Studies
Section 6 - Summary

Other volumes contain data appendices as listed below:

2-1	Air Quality Data
2-2	Climatological Data
2-5	Visibility Data
3-2	Vegetation Data
3-3	Fauna Data
4-2	Aquatic Studies Data
4-3	Periphyton Data
4-4	Benthos Data
4-5	Aquatic Biota Statistical Calculations
5-1	Surface Water Data
5-2	Ground Water Data
5-3	MDP Pump Test Data

In addition to the hard copy data presented in the appendices, data are also presented on 800 bpi magnetic tapes.

CHAPTER 2
ATMOSPHERIC STUDIES

The Tract C-a atmospheric studies program conducted during the reporting period consisted of two elements: (1) measurements of total suspended particulate matter and certain gaseous chemical compounds, and (2) measurements of selected meteorological parameters. The monitoring locations were originally established to measure the ambient air quality generally upwind and somewhat removed from the expected tract development, and at points where tract development might have an effect on the air quality. Simultaneous meteorological measurements were made to allow evaluations of climatology and air quality changes, and for prediction of the dispersion of emissions from tract development.

The level of activity on the tract, principally construction work, has increased significantly during the MDP period. The monitoring program has also been increased in order to measure possible effects on the ambient air quality. Two of the sites that had been previously deactivated were refitted with meteorological instrumentation and put back on-line during the first quarter of the MDP. In addition, one of the reactivated meteorological sites is gradually being refitted with air quality instrumentation. This is scheduled to be completed by September 1979. The ambient air studies monitoring network is depicted on Figure 7-2-1. Parameters measured during the reporting period, the locations at which they were taken, the date of start-up, and the frequencies of measurement are described in Table 7-2-1.

As part of the year-end report, an extensive analysis has been carried out on the data obtained during the most recent four quarters of the MDP program (December 1977 - November 1978, hereafter referred to as the current year). Comparisons have been made with the results from the baseline period (February 1975 - January 1977), obtained from the Final Environmental Baseline Report. A summary of these analyses follows:

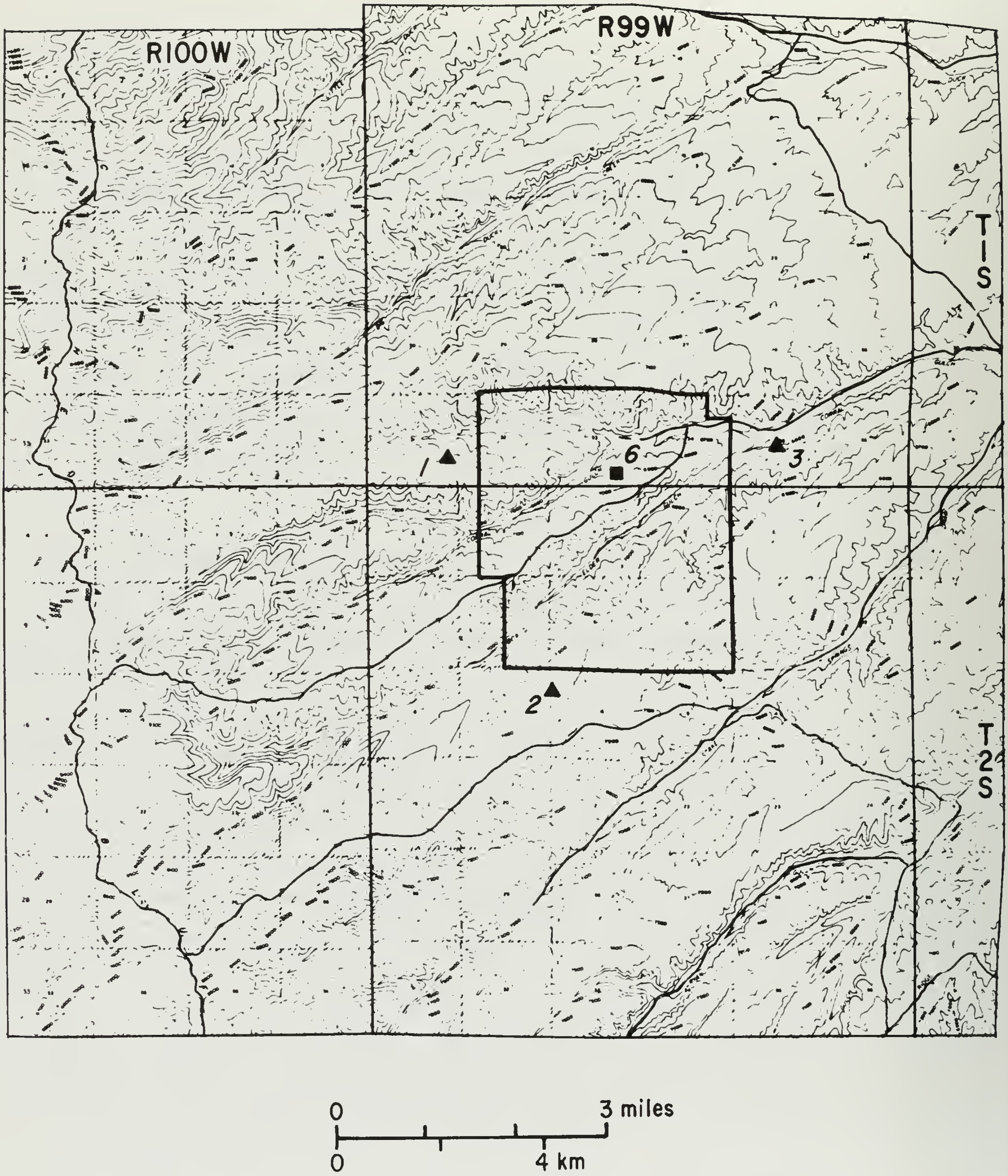

FIGURE 7-2-1

LOCATIONS OF AIR STUDIES MONITORING SHELTERS (▲) AND
TSP STATION (■) FOR THE MDP ENVIRONMENTAL MONITORING PROGRAM

TABLE 7-2-1

AIR STUDIES MONITORING PARAMETERS AND PROGRAM SCHEDULE

Parameter	Location	Start Date	Frequency
Sulfur Dioxide	Sites 1, 3	Nov. 1977	Continuously
	Sites 2, 5	June 1979	Continuously
Oxides of Nitrogen	Site 1	Oct. 1977	Continuously
	Site 3	June 1979	Continuously
Nitric Oxide	Site 1	Oct. 1977	Continuously
	Site 3	June 1979	Continuously
Hydrogen Sulfide	Site 1, 3	Nov. 1977	Continuously
Carbon Monoxide	Site 1	Oct. 1977	Continuously
	Site 3	June 1979	Continuously
Hydrocarbons**	Site 1	Oct. 1977	Continuously
Ozone	Sites 1, 3	Oct. 1977	Continuously
Nitrogen Dioxide*	Site 1	Oct. 1977	Continuously
	Site 3	June 1979	Continuously
Particulates	Site 1, 2, 3	Oct. 1977	Every 4th day
	Site 6**	Nov. 1977	Every 4th day
Wind direction (10m)	Sites 1, 2, 3	Oct. 1977	Continuously
Wind direction (60m)	Site 1	Oct. 1977	Continuously
Wind speed (10m)	Sites 1, 2, 3	Oct. 1977	Continuously
Wind speed (60m)	Site 1	Oct. 1977	Continuously
Wind sigma (10m)	Site 1	Oct. 1977	Continuously
Ambient temperature (10m)	Sites 1, 2, 3	Oct. 1977	Continuously
Temperature (10-60m)	Site 1	Oct. 1977	Continuously
Precipitation	Site 1, 2, 3 & other selected locations	Oct. 1977	Periodically
Solar radiation	Site 1	Oct. 1977	Continuously
Dewpoint (10m)	Site 1	Feb. 1978	Continuously
Visibility	Visibility Shelter		Semi-annually
Noise	15 locations on tract		Quarterly

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* by mathematical calculation.
**discontinued by permission.

- Sulfur Dioxide - Hourly average concentrations recorded were between 0.01 and 0.03 ppm at Site 1 and between 0.01 and 0.11 ppm at Site 3, with most of the values at both sites less than the reliable threshold of detection (0.02 ppm). Annual mean concentrations at both sites for the current MDP period were below the reliable threshold of detection and were therefore set at 0.01 ppm. Mean concentrations during the baseline period were also below the reliable threshold of detection.

- Hydrogen Sulfide - Hydrogen sulfide hourly average concentrations recorded at Site 1 were between 0.01 and 0.04 ppm and at Site 3 were between 0.01 and 0.55 ppm. The annual means at both Site 1 and Site 3 for the current year were 0.01 ppm which are below the reliable threshold for hydrogen sulfide. The annual means at both sites during each of the baseline years were also below the reliable threshold of detection. A few elevated concentrations appeared at Site 3. These were apparently caused by the surface discharge of underground water which contains reduced sulfur compounds. Site 3 is located near the creek into which the groundwater was discharged.

- Nitrogen Oxides - The highest hourly average concentrations for nitrogen oxides and nitric oxide were 0.023 and 0.016 ppm, respectively. The arithmetic means for the period for nitrogen oxides and nitric oxide during both baseline years and the current year are below the reliable threshold of detection of 0.01 ppm.

- Carbon Monoxide - No measurements of carbon monoxide were reported above the reliable threshold of the instrument. The mean carbon monoxide concentrations during the baseline period at both sites were also below the reliable threshold of detection of 1.0 ppm.

- Hydrocarbons - Measurements were made only from December 1977 through February 7, 1978. Thereafter they were discontinued after consultation with the AOSO.

- Ozone - The range of ozone concentrations for the current year was 0.017 to 0.088 ppm at Site 1 and 0.004 to 0.072 ppm at Site 3. The Site 1 mean ozone concentration of 0.057 ppm during this data period contrasts with mean concentrations of 0.033 and 0.035 ppm found at Site 1 during the two baseline years. Better agreement was found with the Site 3 mean ozone concentrations: 0.038 ppm during the current year, and 0.030 and 0.032 ppm during the two baseline years. Variations in calibration procedures probably affected these values. An extensive analysis of the ozone data has been carried out in an attempt to develop a better understanding of the sources of ozone measured on the tract, particularly during periods of elevated concentrations. This is discussed in RBOSC MDP Monitoring Report 3.

- Particulates - Quarterly and annual geometric mean and maximum values of the particulate data for the current year at each of the four sites are presented in Monitoring Report 3. The highest values were recorded at Site 6, located immediately adjacent to the main MDP construction site.

  Twenty-seven percent of the data for Site 6 exceeded the federal 24-hour average primary standard for particulates of 260 $\mu g/m^3$, and 41 percent exceeded at least the secondary standard of 150 $\mu g/m^3$. However, Site 6 is considered anomalous in that it is located immediately adjacent to the MDP construction site where fugitive dust affects the data. The only other violation recorded was one violation of the secondary standard at Site 3.

Detailed analyses performed on the particulate data are described in the year-end report. The following conclusions were drawn from these analyses:

- There is a significant difference in the particulate concentrations during periods with and without snow cover.
- Particulate concentrations measured at Sites 1 and 2 are very highly correlated.
- The meteorological parameters were most effective in predicting particulate concentrations at Site 3 while site activity predictors were surprisingly unimportant.
- At least one-third of the total variability in particulate concentrations at each site is still unexplained.

- Temperature and Stability - The monthly mean temperatures for the three sites were very similar with Site 3 generally slightly lower during the fall and winter months. The mean annual temperatures were 7.6°C at Site 1, 7.9°C at Site 2, and 6.7°C at Site 3. Absolute maximum temperatures and absolute minimum temperatures at Site 1 and Site 2 were very similar. At site 3, more extreme absolute maximum and minimum temperatures than at Site 1 and Site 2 were the rule for every month. The highest on site temperature of 32.4°C occurred in July at Site 3, and the lowest on site temperature of -23.1°C occurred in January at Site 3. Similarly, the average daily maximum and minimum temperatures at Site 3 were more extreme than those at Site 1 and Site 2.

- Dewpoint and Relative Humidity - The mean annual relative humidity during the two baseline years was 36 and 31 percent, as compared to 34 percent during the current year.

- Wind Speed and Wind Direction - During the current year, the Site 1 annual 10-m level wind rose showed the prevalent wind direction to be from the west-southwest, with secondary maxima from the south-southwest and from the southwest. The mean wind speeds associated with these directions were 8.9 mph, 9.4 mph and 6.6 mph, respectively. These data compare favorably with the previous two annual wind roses from the 10-m level at Site 1, which also show the prevalent wind direction to be from the west-southwest. During the current year, the Site 2 annual 10-m level wind rose showed the prevalent wind direction to be from the west, with secondary maxima from the southwest and from the west-southwest. The mean wind speeds associated with these directions were 9.5 mph, 12.2 mph, and 10.6 mph, respectively. These data compare favorably with the two annual wind roses from the baseline period at Site 2, which also show the prevalent wind direction to be from the west. During the current year the Site 3 annual 10-m level wind rose shows the prevalent wind direction, by far, to be from the west (35.8 percent of total annual occurrences), with secondary maxima from the west-southwest and the southwest. The mean wind speeds associated with these directions were 6.5 mph, 7.2 mph, and 10.8 mph, respectively. These data are similar to the two annual wind roses from Site 3 during the baseline period, which also show the prevalent wind direction to be from the west (36.1 and 28.5 percent of the total annual occurrences).

- Precipitation - The current year was the wettest of the three years at all three sites with an annual total precipitation of 9.57 to 11.37 inches measured at each gauge with a full record. During this year, the highest precipitation amounts were recorded during March and November, with the latter month including unusually heavy amounts of snow. The driest month was October.

- Solar Insolation - The annual mean solar insolation for each of the three data periods (two baseline years and current year) was 0.3 langleys/min, equivalent to 432 langleys/day.

- Visibility - Visual ranges obtained during Spring and Fall 1978 were generally high; 95 percent of the measurements were greater than 43 miles, 50 percent were greater than 71 miles. Daily mean visual ranges exhibited large variations during the periods, ranging from 29 to 102 miles; variations in mean hourly visual ranges were small, however, and were less than 15 miles in each view. The generalized visibility (mean visual range) was found to be 79 miles for the year. These data compare favorably with baseline values.

- Noise - Sound level averages taken during the January survey ranged from 45-66 dBA. These values reflected the spatial removal from site activities. Sound level averages taken during the March study were higher than during January, ranging from 82-110 dBA. However, these sites were in closer proximity to activity areas and were taken during periods of considerable activity. Sound level averages during August ranged from 61-76 dBA. The range in October was 61-78 dBA. These latter two values agree well with March data, which were taken at the same locations.

CHAPTER 3
TERRESTRIAL STUDIES

The terrestrial studies MDP monitoring program is designed to detect and evaluate those impacts affecting the soil, vegetation or faunal components of the terrestrial ecosystem on or near Tract C-a. The terrestrial monitoring program is based on an assessment of current knowledge of MDP mining operations. Environmental parameters which are either expected to be affected by developmental activities or are ecologically or politically important have been included in the terrestrial monitoring program. Parameters included in the current program are listed on Table 7-3-1. The locations of the range and browse sampling sites are depicted on Figure 7-3-1. Mule deer and feral horse studies encompass the tract and a three mile wide area around it. Aerial photography studies encompass the tract and a five mile wide area around it.

A summary of results from other terrestrial programs follows.

- Vegetation Distribution (Mapping) - Aerial photography revealed small areas of disturbance in 1978 when compared to the baseline. No major changes in distribution of vegetation types or vegetation stress were noted, however.

- Range - Production of grasses and forbs in mixed brush communities totaled 185 lbs/acre in 1978. This compared to annual total production for these groups of 207 and 245 lbs/acre in 1975 and 1977, respectively. Production of grasses and forbs in the pinyon-juniper type totaled 38 lbs/acre in 1978 compared to 101 and 67 lbs/acre in 1975 and 1977. Total production for these plants in the upland sagebrush type was 110 lbs/acre in 1978, 269 lbs/acre in 1975 and 111 lbs/acre in 1977.

  In general, production substantially decreased from 1975 to 1977-1978; explanations for this decrease are not apparent.

TABLE 7-3-1

TERRESTRIAL STUDIES MONITORING PARAMETERS AND PROGRAM SCHEDULE

Parameter	Location	Start Date	Frequency
Trace Metals (Collection & Storage of Soils and Vegetation Samples)	On Tract	Aug. 1981	Annually
Soil Conductivity Studies	On Tract	Aug. 1981	Annually
Vegetation Mapping	Tract C-a and 5 mile Perimeter	May 1978	Annually
Range Productivity and Utilization	See Figure 7-3-1	April 1978 (establish plots)	Annually (in Sept.)
Browse Condition and Utilization	See Figure 7-3-1	May 1978	Annually
Mule Deer Density Studies	Tract C-a and 3 mile Perimeter	Sept. 1977	Semi-annually (May, Sept.)
Feral Horse Abundance	Tract C-a and 3 mile Perimater	Jan. 1978	Annually
Threatened or Endangered Species	Tract C-a and Adjacent Areas	Sept. 1977	Opportunistically

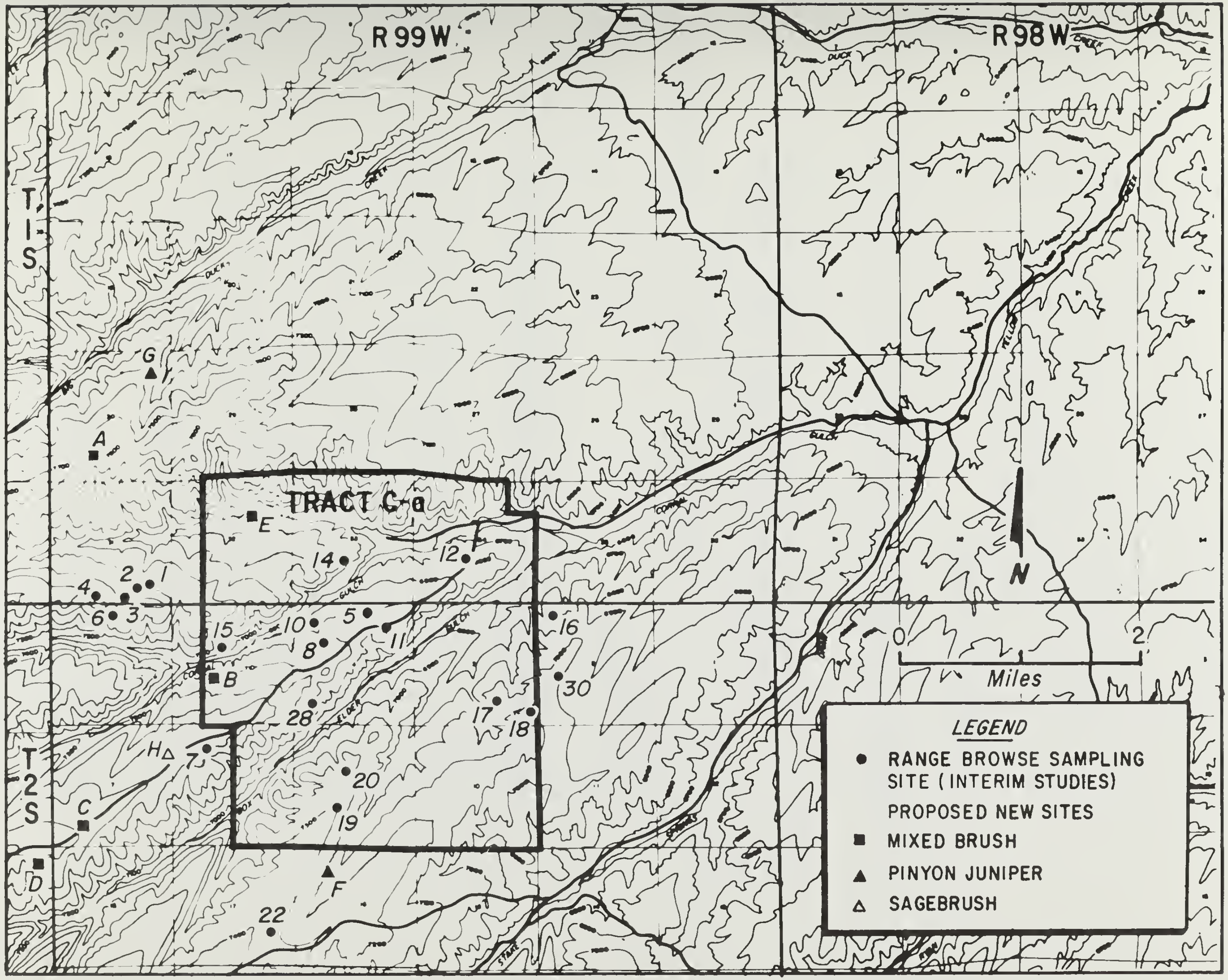

FIGURE 7-3-1

LOCATIONS OF RANGE/BROWSE MONITORING SITES FOR THE MDP MONITORING PROGRAM

The 1977 and 1978 production levels were more similar although 1977 estimates were generally higher. The higher 1977 estimates are probably related to the late summer rains which occurred in late July and August of 1977 and could have affected the production measured in August. Precipitation during the 1978 growing season was concentrated in May and June; the effects of spring precipitation were probably negated by the time of the September sampling.

- Browse - A summary of the browse utilization results for Spring 1976, 1977 and 1978 is presented as follows:

Average Utilization (% Utilization)[1] in Three Vegetation Types During April 1976, May 1977 and May 1978 On and Near Tract C-a

	April 1976	May 1977	May 1978
Mixed Brush	12	17	7
Pinyon-Juniper	27	24	31
Upland Sagebrush		6	25

[1] The comparison is for the habitat type in general; the same transects were not sampled during each period nor was the sample size equal.

During the first year of MDP operations (1978), pinyon-juniper and sagebrush had the highest utilization while utilization in mixed brush decreased from 1976 and 1977. Utilization in the sagebrush type was substantially higher than the utilization measured during 1977. A comparison of the individual transects indicated that the increase in utilization was probably related to feral horse use. Therefore, it is doubtful that MDP activities affected utilization in the sagebrush area.

- Mule Deer - The estimated average number of mule deer per square mile in the study area during the winter period, 1977-78, ranged from 9.0 to 100.0. The average number per square mile during the summer period ranged from 4.7 to 28.5. The average winter use by square mile for the entire study area was 50.9; in summer 15.3. RBOSC data indicate that the density of mule deer on the RBOSC study area falls within the expected range for that part of the Piceance Basin as reported by the Colorado Division of Wildlife.

Number of deer killed on the 13 mile stretch of County Road 24 leading into the tract has been low. Daily counts tallied one dead animal along this route from February through December 1978.

- Feral Horses - The January 1978 feral horse survey revealed the presence of seven bands of horses totaling 53 individuals in the study area. Total number of horses estimated in the area is from 80-100 individuals. Horses were observed regularly throughout the area, many in close proximity to activity sites.

- Threatened or Endangered Species - Tract C-a does not provide critical habitat for any state or federally endangered species. Bald eagles are occasionally seen during the winter months and may utilize road-killed animals as a source of food.

CHAPTER 4
AQUATIC STUDIES

The aquatic studies MDP monitoring program is designed to identify changes in the aquatic ecosystem which result from tract development, provide continuing information on natural variation and ecosystem characteristics, and provide a means for mitigating adverse impact, should they occur. The current program was designed in view of baseline data and an impact assessment of potential development effects. The six sampling sites currently being monitored are depicted on Figure 7-4-1. Both abiotic and biotic parameters are being monitored. A list of these parameters, the locations at which the data are collected and the data collection schedule are identified on Table 7-4-1.

In order to identify changes in the aquatic system during the last three years and to describe the relationship of such changes to development, the baseline and MDP data have been carefully compared in Monitoring Report 3. A brief summary of the current year's data and results of these comparisons is given in the following pages.

- Physical Measurements - Physical parameters (width, depth, velocity) at Stations 13 and 14 on Corral Gulch were affected by increased flows of dewatering discharge during the reporting period. Other physical parameters were not significantly affected, however. Several parameters, including pH, alkalinity, conductivity, and dissolved oxygen, were affected at the two Yellow Creek stations by the 1977 drought conditions. No change was observed in physical parameters measured in the White River.

- Water Quality - Water quality is measured as a part of the aquatic program at only two stations at the White River. More extensive water quality data are presented in Chapter 5 -

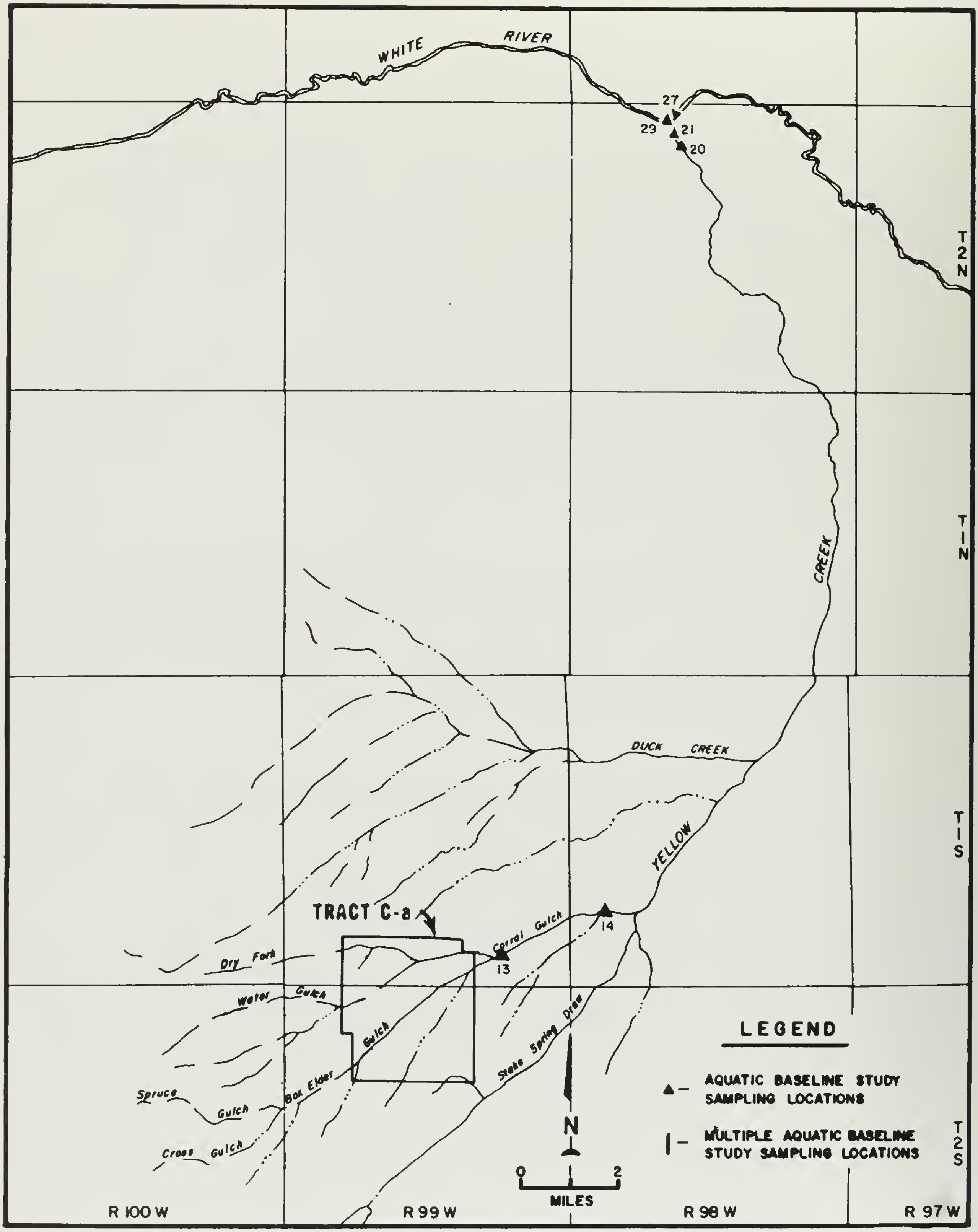

FIGURE 7-4-1

LOCATIONS OF AQUATIC STUDIES SAMPLING SITES FOR THE MDP PROGRAM

TABLE 7-4-1

AQUATIC STUDIES MONITORING PARAMETERS AND PROGRAM SCHEDULE

Parameter	Location	Start Date	Frequency
	ABIOTIC		
Physical Measurements			
Stream Velocity	Stations 13, 14 20, 21, 27, 29	Oct. 1977	5 times/year (April, June, July, Aug., Oct.)
Turbidity			
Dissolved Oxygen			
pH			
Specific Conductance			
Water Temperature			
Depth			
Width			
Stream Substrate			
Water Quality Measurements (White River)			
Boron	Stations 27, 29	Oct. 1977	5 times/year (April, June, July, Aug., Oct.)
Calcium			
Chloride			
Fluoride			
Magnesium			
Nitrate			
Orthophosphate			
Potassium			
Total Phosphate			
Silica			
Sulfate			
Sodium			
Alkalinity			
Total dissolved solids			
	BIOTIC		
Periphyton	Stations 13, 14 20, 21, 27, 29	Oct. 1977	5 times/year (April, June, July, Aug., Oct.)
Benthos	Stations 13, 14 20, 21, 27, 29		5 times/year (April, June, July, Aug., Oct.)

Hydrology. Water quality at the two White River stations doesn't vary substantially from baseline conditions.

- Periphyton - Total cell densities for periphyton exhibited much variation but were generally lower at most stations during the current year than during baseline. This lower cell count was reflected in lower diversity indices. This trend was especially noted at Stations 13 and 14 which also underwent a considerable change in habitat characteristics, as noted earlier. Variations were noted between seasons of the years as well as by station. These changes probably reflect some natural variation as well as effects of development activities.

  At certain times of the year, total mean cell densities were greater than values recorded during baseline. This was noted in April and July at Station 20 on Yellow Creek. However, densities noted in October at this station were substantially lower. Densities at both treatment and control stations on the White River were almost exclusively lower. Natural flood conditions may have been responsible for this trend. Trends noted during the current year reflect changes, but do not necessarily indicate adverse impact, as demonstrated by the continued diversity of the communities despite scouring from high flows, and changes in total cell densities and organic weights. The communities identified during the current year are indictive of oxygenated, highly alkaline waters such as were present during the baseline period.

- Benthic Macroinvertebrates - Lower numbers of macroinvertebrate species were noted at Stations 13 and 14 during the reporting period. The previously well-balanced and diversified benthic community at Station 13 was altered by the disappearance or reduction in numbers of several benthic groups, including Baetidae, Plecoptera, Naididae, and Chironomidae. Station 14 showed trends toward a depositional habitat with an increase in numbers of Tubificidae and a decrease in Chironomidae larval. As discussed earlier, the physical characteristics of both stations were affected by dewatering discharge. Additionally, Station 14 has undergone several habitat conversions over the last four years. These habitat alterations from pond to flood stream to pond again have resulted in considerable variation in the benthic community at this station. These alterations have also demonstrated the adaptability of the benthic community to drastic alterations in habitat. Therefore, while changes in the habitat have affected the biotic component, these changes are not unique to oil shale development. They have resulted from natural flooding and runoff as well as from dewatering discharge. Short-term changes such as those noted to date cannot be assessed as adverse.

Benthic populations at Station 20 on Yellow Creek remained stable during the study period and compared favorably with baseline. Small changes in the benthic community were noted at the other Yellow Creek Station (21), but no definite trends were noted.

The two White River Stations (27 and 29) continued to support the most diverse, stable, and well balanced benthic community of all the study sites, as with baseline.

CHAPTER 5
HYDROLOGY

The Tract C-a hydrology program is comprised of two distinct elements - environmental and operational hydrologic studies. The environmental hydrology program provides data necessary to satisfy lease stipulations and conditions of approval from the AOSO; assess impacts of ongoing development activities, provide input for other environmental disciplines, and supply information necessary to institute mitigative measures, if necessary. The operational hydrology program is carried out to: provide engineering input to mine design and dewatering; collect data for compliance with permit stipulations; and describe the effects of dewatering and reinjection.

The environmental hydrology program supplements baseline data and is used as a means of providing current data for comparison purposes. This program was initiated in September 1977. The major elements of the environmental program are identified on Table 7-5-1. The locations of the six springs currently being monitored are shown in Figure 7-5-1. The locations of other hydrologic monitoring sites identified in Table 7-5-1 are depicted in Figure 7-5-2.

The data collected as a part of the operational monitoring program are identified on Table 7-5-2. The locations of the sampling locations are shown on Figure 7-5-3. The results of these two programs are briefly summarized below.

- Surface Water - Of the six gaging stations, only one, Rinky Dink Gulch, failed to show any flow during the reporting period. The natural flows for 1978 were similar to earlier data. Box Elder Gulch flowed with more frequency than in 1977, but Corral Gulch and Yellow Creek flow records were quite similar to baseline data. Flows recorded in 1977 definitely exhibit effects of the drought at all stations

TABLE 7-5-1

ENVIRONMENTAL HYDROLOGY MONITORING PARAMETERS AND PROGRAM SCHEDULE

	Frequency		
	Continuously	Quarterly	Semi-Annually
SURFACE WATER PROGRAM			
Stream Gaging Stations			
DOC Fractionation (once initially)			
Conductivity	x(6)		
Temperature	x(6)		
Flow	x(6)		
Limited water quality analysis		x(6)	
Complete water quality analysis			x(6)
Springs and Seeps			
DOC Fractionation (once initially)			
Flow		x(6)	
Conductivity		x(6)	
Temperature		x(6)	
pH		x(6)	
DOC		x(6)	
Surface Water Impoundments (which contain water)			
Complete water quality analysis			x
Limited water quality analysis		x	
GROUNDWATER			
Alluvial Holes			
DOC Fractionation (once initially at new holes)			
Water levels	x(3)	x(5)	
Limited water quality analysis		x(8)	
Baseline water quality analysis			x(8)
Dual Aquifer Monitor Holes			
Water levels	x(6)		
Complete water quality analysis			x(6)

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(6) Indicates the number of sampling sites

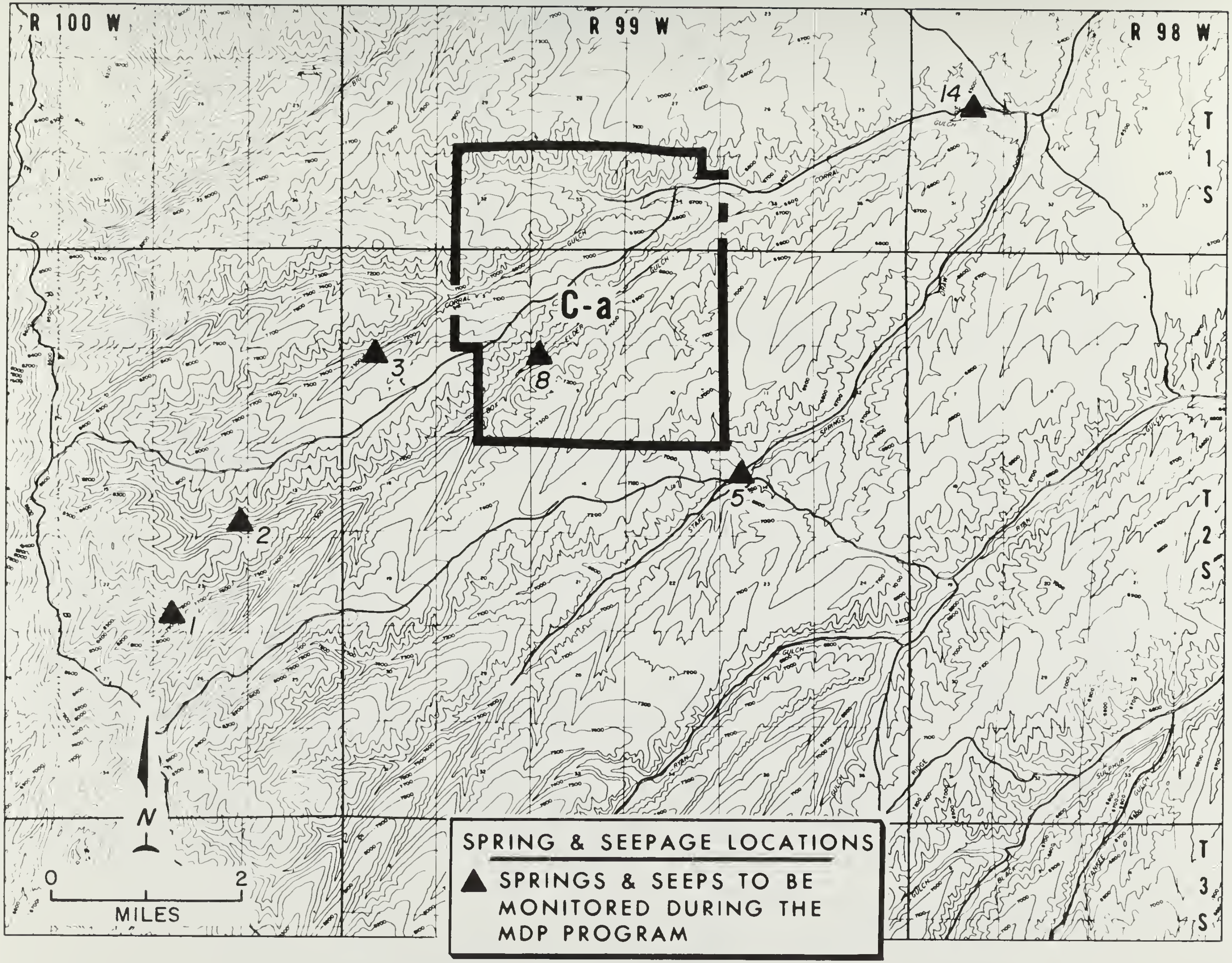

FIGURE 7-5-1

LOCATIONS OF SPRINGS AND SEEPS MONITORED AS A PART OF THE MDP ENVIRONMENTAL HYDROLOGY PROGRAM

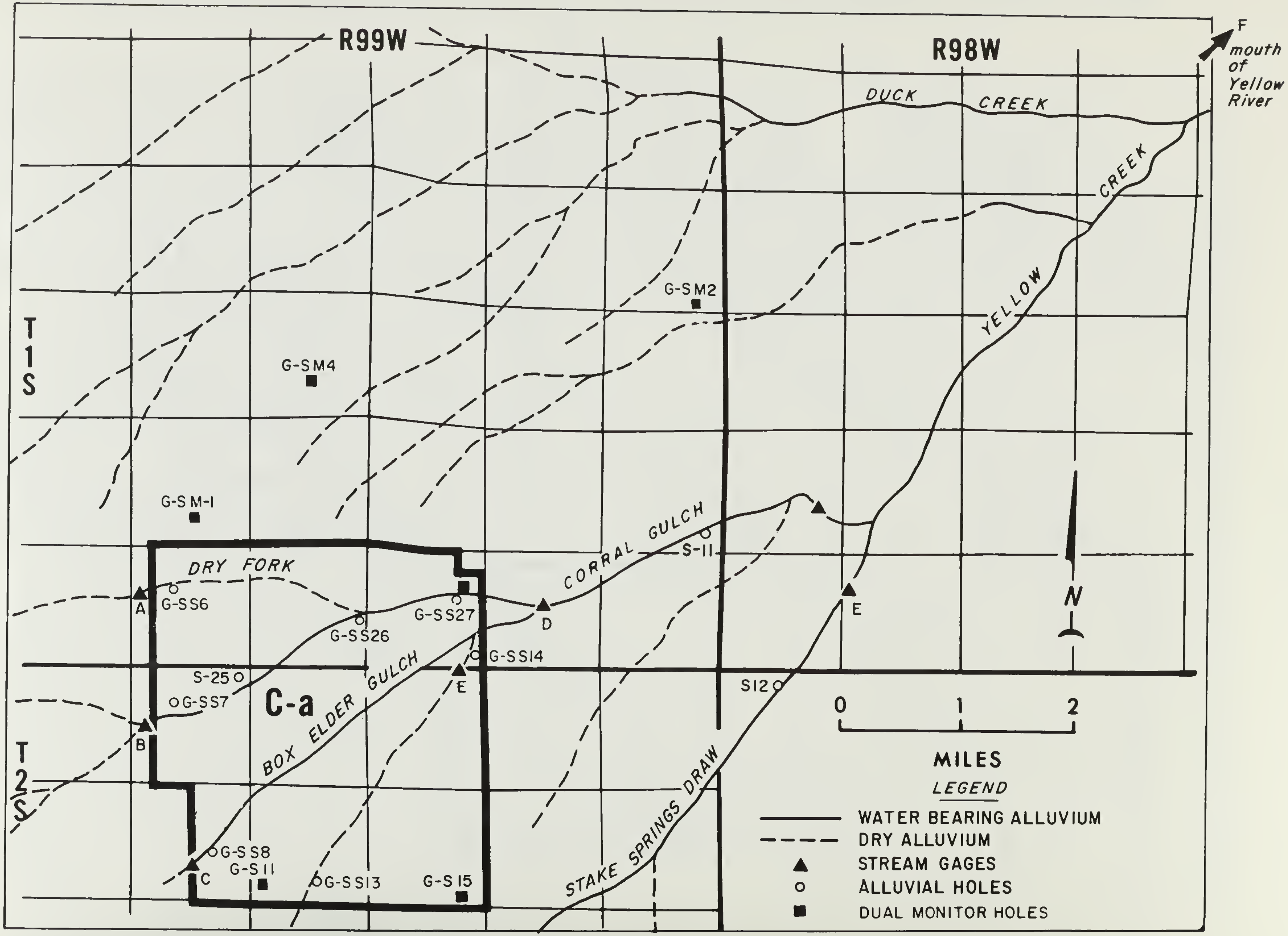

FIGURE 7-5-2

LOCATIONS OF MONITORING STATIONS FOR HYDROLOGY STUDIES DURING THE MDP

TABLE 7-5-2

COMPONENTS OF THE OPERATIONAL HYDROLOGY MONITORING PROGRAM

Requirement	Parameters	Locations
CDOH Subsurface Disposal Permit	Flow/water level, Limited water quality analysis, Physical characteristics, Semi-annual complete water quality analysis.	Gaging stations, Reinjection points, Alluvial holes, Upper aquifer holes
NPDES Permit	Flow, pH, Conductivity, TSS, TDS, Oil and grease, Fluoride, Boron	Discharge points
MDP pump test Monitoring	Flow/water level, Conductivity, pH, Temperature	Gaging stations, Upper aquifer holes, Alluvial holes
	Channel cross-section	Streams
	Limited Water quality analysis	Impoundments
	Water level	Lower aquifer holes

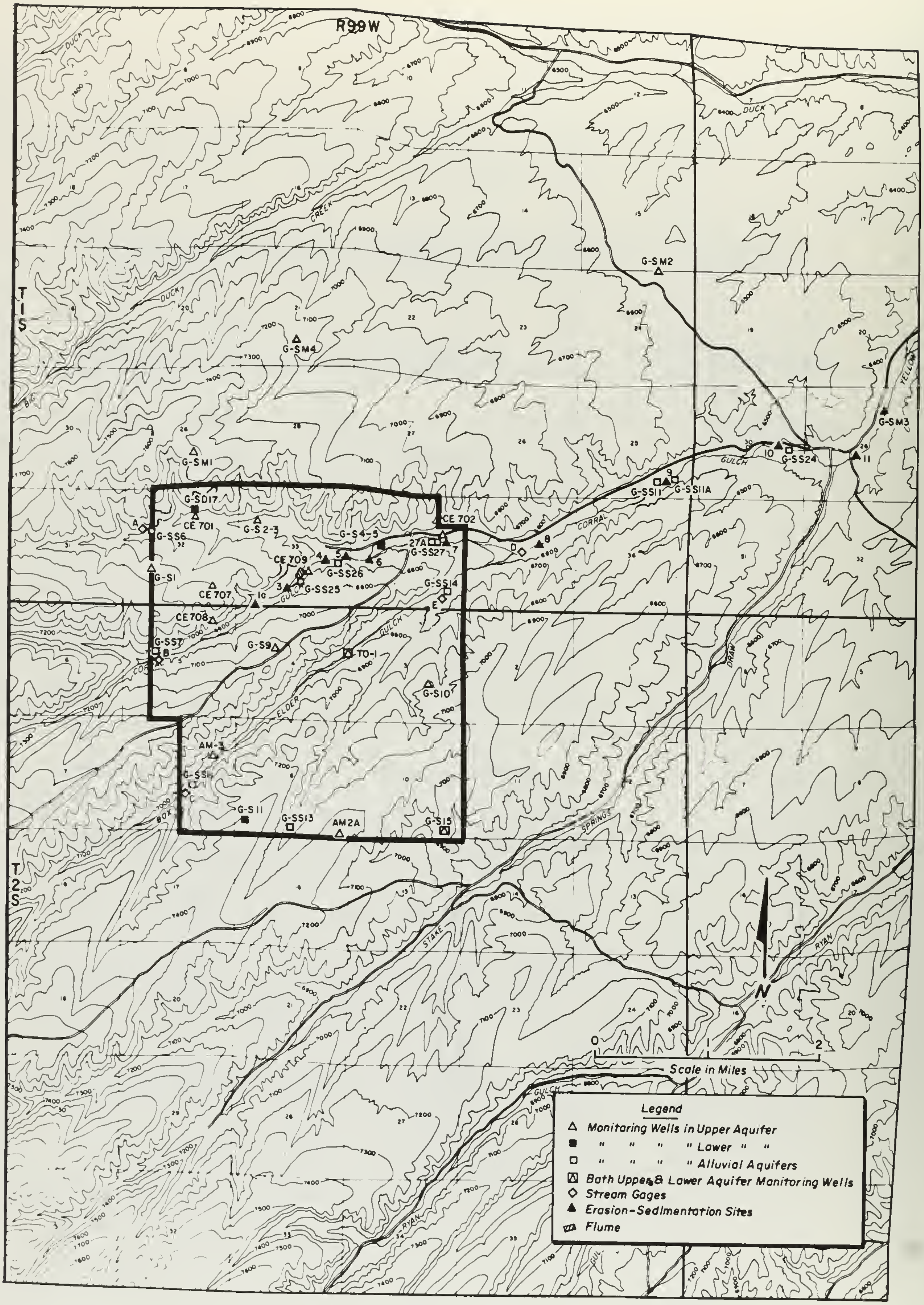

FIGURE 7-5-3

LOCATIONS OF OPERATIONAL MONITORING HYDROLOGY SAMPLING SITES except Dry Fork, which did not register a flow reduction. Examination of the physical data collected at surface gaging stations during 1978 indicates that concentrations of most constituents varied outside expected statistics. Correlations noted between various constituents during baseline were in some cases no longer detected. A complete discussion of the statistical analysis completed for these data is presented in MDP Monitoring Report 3.

- Springs and Seeps - Temperature, conductivity, flow, and pH for the six springs studied is discussed in the monitoring report and compared with baseline data. Significant differences were reported for 10 of the chemical parameters in the comparison. These variations were related in part to discharges from dewatering wells but are not fully understood.

- Alluvial Groundwater - Most of the alluvial wells in the study area remained dry throughout the reporting period. This approximates the baseline condition. For the remaining wells where data were collected, the following can be noted. Physical data for two of the alluvial wells (G-S S-7 and G-S S-8) showed no significant difference from baseline values. Water level in G-S S-27 appears to have been influenced by mine water discharge.

  Statistical analyses were performed to determine if changes in water level increases could be related to water quality. A complete discussion of these analyses appears in MDP Monitoring Report 3.

- Upper and Lower Aquifer Water - Water levels in one of the deep oil shale aquifer wells showed definite changes in upper and lower aquifers and one other well showed a change in upper aquifer levels in 1978. These changes appear to be related to dewatering and reinjection activities. These water levels are being watched carefully to determine the effects of the dewatering program on the upper aquifer in the area. Other wells in the monitoring program show no affects.

Chemical data for deep aquifers taken during 1978 compared favorably with baseline. Only a few variations from accepted statistics were noted. These changes were related to factors other than tract development. Therefore, water quality has apparently not been affected by tract development to date.

- Operational Monitoring - Flow data taken during the reporting period reflect discharges to Corral Gulch during the pump testing program. Likewise erosion data indicate that initial discharges to Corral Gulch resulted in changes in the stream channel profiles. However, these changes leveled off after the initial disturbance and have remained relatively stable since.

  Subsurface disposal permit data have been reported monthly since the onset of the testing program. These reports are available through the Colorado Department of Health.

  Data taken in compliance with the NPDES permit were reported quarterly during 1978. These data can similarily be obtained from the Colorado Department of Health.

Form 1279—3
(June 1984)

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